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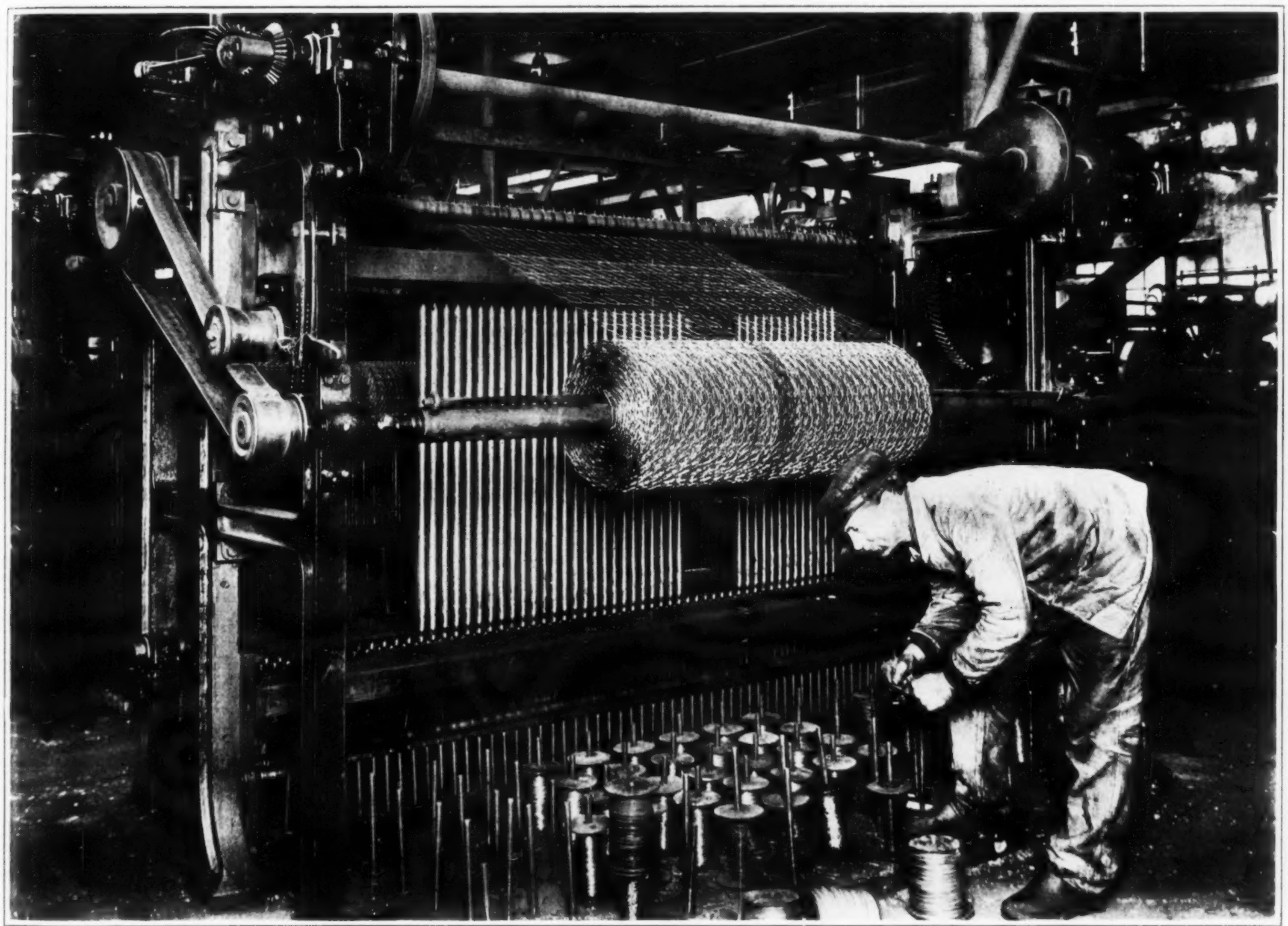


Fig. 1.—Front View of Netting Machine.

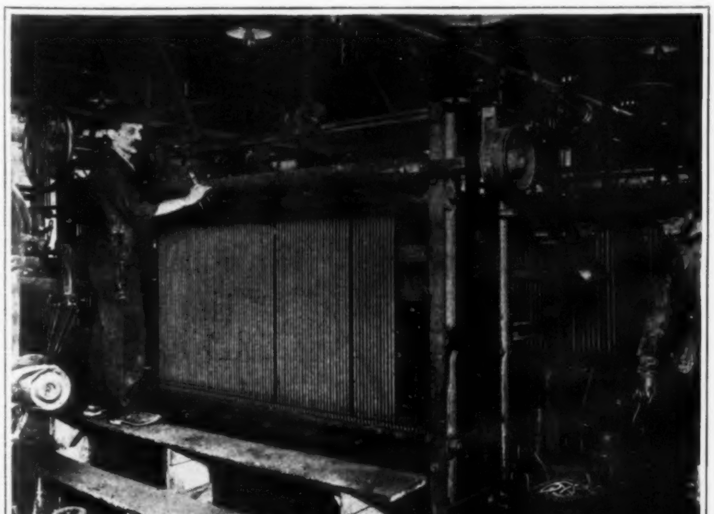


Fig. 2.—Rear View of Netting Machine.

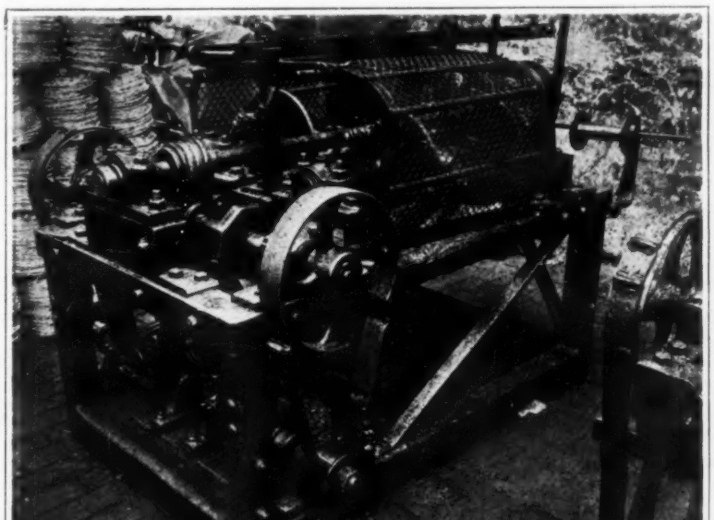


Fig. 3.—Machine for Making Borders.

THE MANUFACTURE OF WIRE NETTING.

Traveling At High Speeds—II.*

A Review of Records in all Fields of Locomotion

By Prof. Hele-Shaw, F. R. S.

Concluded from Supplement No. 1874, page 359.

Turning to the last of the three elements, namely, air, it was my intention to have dealt with it at greater length than I now find it is possible to do, but, thanks to the daily press and illustrated journals this subject is as fresh in the minds of everybody as it is familiar. It is not necessary in this room to remark that the wild talk of almost incredible speeds has very little foundation. Bodies move quickly enough in the air, and very often far too quickly, but what is generally overlooked is that the difficulty of the problem lies in the matter of supporting the body in the air rather than moving through it, a problem which is very much simpler for land and water. The human body itself, while of about equal specific gravity with water, is about 800 times as heavy as air, and probably, taken in conjunction with the motor and aeroplane, the weight which has to be supported is several thousand times as heavy relatively to the air which it displaces. Inasmuch as the support of the air necessitates the use of an inclined plane and a corresponding expenditure of energy, the speeds made horizontally and independently of the wind have, at the present time, barely exceeded half the record speeds made on wheel vehicles. As a matter of fact, only the other day the record for passenger flight was broken by M. Nieuport at Mourmelon, when he flew with two passengers for 1 hour 4 minutes 58 1-5 seconds, and covered 68.35 miles at an average speed of 63 miles per hour. It is difficult to say exactly what the true record speed at present is round a course, but we may safely take it as probably under 70 miles an hour, the record being, so far as I have been able to ascertain, by M. Nieuport on March 9th this year at Chalons—68 miles 168 yards in the hour.†

We now see the relative position of the record speeds in the three elements on our speed chart, Fig. 4, and it is obvious that, while on land the speed has far exceeded that of the fastest animal, on water it has probably only recently surpassed that speed, while in the air, in all probability, it is considerably below it. We must not, however, from this argue that flying speeds will for safe flying machines rise so far beyond that of birds as land locomotion has risen above the speed of animals, for it looks as if the speed records on land would be at least equal for some time, if not greater, than that possible with safety in the air. At the same time, there is no doubt that speed is the one great factor of safety in flying, and aerial speed records are sure to go on rising year by year, but time does not permit me to pursue this subject further to-night.

Instead of vague surmises as to what may be done in the future, let us spend a few minutes looking into the question of these limits.

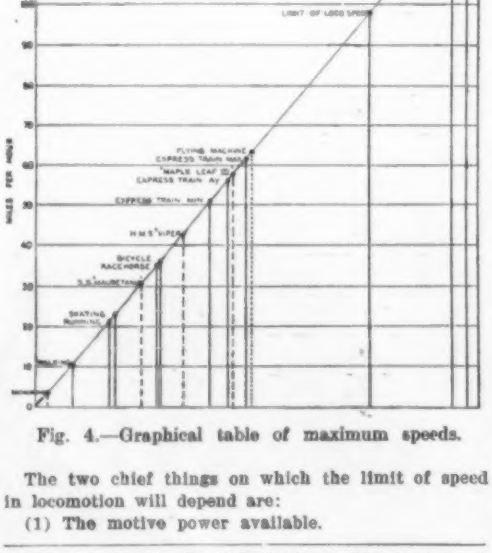


Fig. 4.—Graphical table of maximum speeds.

The two chief things on which the limit of speed in locomotion will depend are:

(1) The motive power available.

(2) The resistance, and the manner in which those resistances operate.

But inasmuch as we are not merely considering the human body as a projectile, we do not take into account such speeds as have been attained by man in such a way as, for instance, in a high dive, say, of nearly 100 miles an hour, or even the thrilling descents such as are made in a bob-sleigh. We must really consider speeds which can be made with safety; and there are two further questions which arise:

(1) Knowledge as to possible obstacles, coupled with a power of safely stopping within the distance to which our knowledge extends, i. e., signaling and brakes.

(2) Vibration.

These two latter really limit conditions of high speed for practical traveling.

In daily life, the limiting conditions of speed in traveling depend largely on the distance in which we can safely come to rest. As the population increases and there is less room for everybody, the question of brake-power becomes more and more important, and with it, of course, the power of starting from rest quickly, or, to put it in scientific words, the power of rapidly effecting both positive and negative acceleration. We are very differently constructed from the particles of air in which we live, and do not yet travel as fast, but fortunately, as yet, we are not quite so crowded, since, according to Lord Kelvin, they move about among each other at the ordinary atmospheric temperature and pressure at an average speed of 1,800 miles an hour, and they cannot avoid fewer than five thousand million collisions in every second. As you see in the streets, and as I shall show you with regard to suburban traffic, high speed is becoming more and more a question of starting and stopping rapidly. I remember in the early days of cycle racing, in order to lighten the machine, the racing men had no brake, until they found what is now well recognized—that the speed at which you can travel depends upon the safe distance in which you can stop.

Owing largely to the perfection of the continuous brake, the speed records obtained on several railways are from 96 to 98 miles an hour, which I have put down on the diagram, and it is possible that 100 miles an hour has been reached, and even exceeded; but this is a very different matter from the highest express running which is found really practicable. You will see on the speed chart, Fig. 4, a line indicating the average railway speed of the fastest running (without stopping) for the fifteen principal railways of the country. The average distance of the quick runs is 51.7 miles, and the average fastest running is 56.2 miles per hour. On either side of this line are the two fastest speeds, namely, 61½ miles per hour for 44½ miles on the North-Eastern Railway from Darlington to York, and the lowest of these is 51 miles an hour, over the 51 miles from Victoria to Brighton on the London, Brighton and South Coast Railway. This shows how little the high speeds of all the railways of this country differ from one another, and indicates, at any rate for the present conditions, the highest speeds of traveling found suitable to our wants.

I will take as another illustration of actual traveling the case of suburban traffic; and we have only time for one example, namely, the traffic from the Mansion House to Ealing on the Metropolitan and District Railway, the details of which have been kindly provided by Mr. Blake, the superintendent of the line. Fig. 5 shows in graphical form the quickening in speed from the opening of the line in 1880 to the present time. You will notice that this increase of speed has been followed by remarkable results; the first immediate result is the possibility of a greater number of trains, and the curve of the rise in the number of trains is shown on the diagram; but the really significant feature is the rise in the number of passengers carried, 35,000,000 to 72,000,000, which is the direct result of the increased facility in traveling. Now it is in such a case that the importance of the signaling and braking come to be almost pre-eminent, quite apart from the mere mechanical problem.

I may point out that the District Railway, in common with most other electric railways of this country, has what is known as a "track system of signaling," which, apart from the fact that the driver holds what is known as "the dead man's handle," which upon being released causes the train to stop, the train independently stops itself upon coming to a portion of the line not cleared by the previous train.

I have given you some examples that this country is not so far behind as we are so often told; and we have another in the fact that the District Railway has created a most beautiful system, by which the signalman is now absolutely independent of fog or darkness; he can see every train, or rather its picture, as it moves along the track in an illuminated diagram in front of him. No one could watch, as I have had the privilege of doing, the operation of this system in a signal-box without feeling certain that it must become universal in a very short time.

With regard to the question of vibration and oscillation, these are gradually being diminished as machinery is perfected. They are important, and may become very serious. They have, for instance, given Mr. Brennan much trouble in perfecting his wonderful monorail, with which we shall yet perhaps see every record broken; and you may remember Mr. Parsons' statement in this hall that an ounce out of balance on the Laval turbine represents an actual pull at the axle of no less than a ton.

There are many other features which I have not time to enter into. There is one, however, which I will briefly touch upon, as it is the secret of our safe railway traveling. I will illustrate the matter by an experiment in which a pair of wheels connected by an axle keyed firmly to both are made to run along a pair of rails. You will notice that the wheels are "coned" instead of having cylindrical rims, and it is easy to see that any movement sideways is at once corrected automatically, and within certain limits no rim at all is required for the flanges in order to keep the wheels upon the rails. The same model illustrates the important property of "super-elevation" applied to the outer rail of a curve. You will see, with proper super-elevation, the wheels run safely round this sharp curve even at a high speed. Time does not permit me to enter at any length into the question of development of power or the nature of resistance to motion. I will content myself with saying that, with regard to the former, we have already seen that the power of flight has been made possible by the invention of the small high-power internal-combustion engine, and it is to the same invention that the marvelous speeds obtained with small boats is due. We can scarcely realize what will be the result when the internal-combustion engine has been developed further for the purpose of locomotion. Our prospects of a further

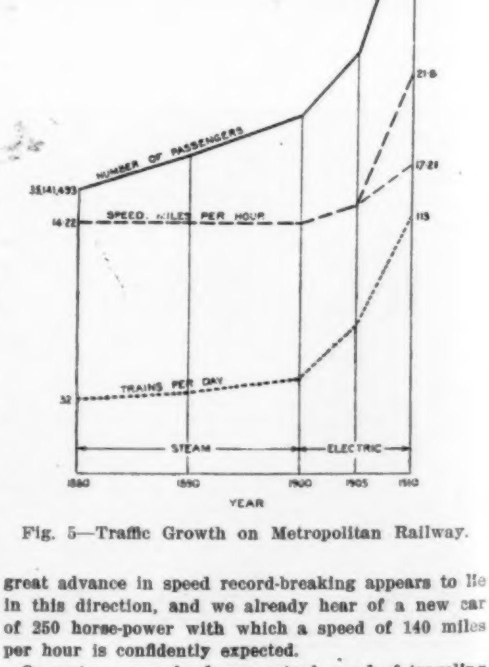


Fig. 5—Traffic Growth on Metropolitan Railway.

great advance in speed record-breaking appears to lie in this direction, and we already hear of a new car of 250 horse-power with which a speed of 140 miles per hour is confidently expected.

On water, as on land, our actual speed of traveling falls far below maximum speed records, and we do not commercially travel at much more than half the possible speed, as you see from Fig. 4, where the

* Paper read at the Royal Institution on May 4, 1911 and published in *Nature*.

† This has since been exceeded. Nieuport reached a speed of 82,73 miles per hour on June 21. 1911.

speed of the "Mauretania" is shown graphically. Fig. 5 is a chart of the progress of Atlantic shipping, taking the Cunard line as an example, and these curves indicate that the rate of increase of horse-power and tonnage is rising far faster than the rate of speed, and indicates how relatively highly the rate of power has increased for the gain of speed.

We have now passed briefly in review the nature of the problems which confront us in our continuous efforts to increase the safe and practical speeds of mechanical locomotion. We see that at the root of it all lies the question of artificial power and the harnessing in compact and convenient form the stored-up sources of energy in nature in order to overcome the opposing resistance, and we can realize that, although we have obviously reached the limits of animal locomotion, we are far from having reached any limitation in regard to the speed of self-propelled machines. We see that in all three forms of locomotion, earth, air, and water, the advance has been far more rapid during the last few years than ever before, and we can realize that there is yet a considerable margin by which speed of traveling could be increased as the demand for it is made; and nothing is more certain than that the demand will be made.

I began my lecture by pointing out why speed was instinctively taken as a test and a measure of locomotion from the earliest times. Shakespeare makes one of his characters say, "The spirit of the time shall teach me speed," but he might have said this of any period equally with that of King John, though never more so than of to-day, for the changes in the requirements of civilization have only altered in detail, and speed is of as much importance as ever in the struggle of life. The probably unconscious recognition of this fact has always led the question of speeds to be raised as prime factors in proposals for new modes of locomotion, and it is interesting to look back only a comparatively few years to see, in raising these views, this was always the case, but how little any ideas of future possibilities were realized. When George Stevenson, backed up by a few courageous and enterprising men, was fighting the battle of the railway, and in particular trying to secure the passing of the bill for improved communication between Liverpool and Manchester, the question of speed was the most important one raised; the opposing counsel, Mr. Harrison, spoke as follows: "When we set out with the original prospectus, we were to gallop, I know not at what rate; I believe it was at the rate of 12 miles an hour. My learned friend, Mr. Adam, contemplated—possibly alluding to Ireland—that some of the Irish members would arrive in the wagons to a division. My learned friend says that they would go at the rate of 12 miles an hour, with the aid of the devil in the form of a locomotive, sitting as postilion on the fore horse, and an honorable member sitting behind him to stir up the fire, and keep it at full speed. But the speed at which these locomotive engines are to go has slackened: Mr. Adam does not go faster now than 5 miles an hour. The learned sergeant (Spankie) says he should like to have 7, but he would be content to go 6. I will show he cannot go 6; and probably, for any practical purposes, I may be able to show that I can keep up with him *by the canal*. . . . Locomotive engines are liable to be operated upon by the weather. The wind will affect them; and any gale of wind which would affect the traffic on the Mersey would render it *impossible* to set off a locomotive engine either by poking the fire or keeping up the pressure of steam till the boiler was ready to burst." The committee, after hearing the arguments of Mr. Harrison, threw out the bill for the Liverpool and Manchester Railway by a majority of 19 to 13. In order to realize that the above ideas were general, the following may be quoted from the great journal of the day, *The Quarterly*: "What can be more palpably absurd and ridiculous than the prospect held out of locomotives traveling *twice as fast as stage coaches*. . . . We trust that Parliament will, in all railways it may sanction, limit the speed to *eight or nine miles an hour*, which we entirely agree with Mr. Sylvester is as great as can be ventured on with safety."

Even in more recent times we see the struggle for the road locomotion question turned on one of speed, and the supporters of the new departure were unable to make any headway for many years, partly because the speed limit was put at between 3 and 4 miles an hour, that is, the limit of a walking man. A few

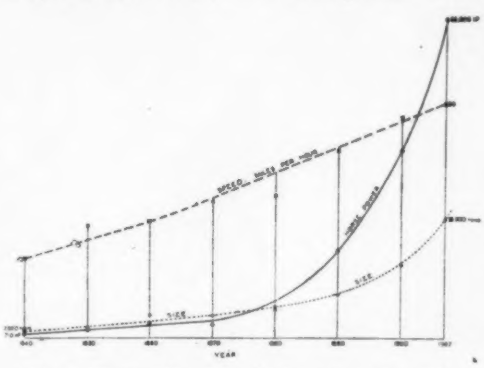


Fig. 6—Progressive Atlantic Steamers (Cunard).

years ago the speed of 12 miles an hour which, after a great struggle, was obtained, gave place to 20 miles an hour. You can see from the diagrams which Mr. Legres gave in a recent paper before the Institution of Mechanical Engineers, and which have been brought up to date, how the speedier self-propelled vehicle is leading to the disappearance of the horse, at any rate in London, and the difficulty which most people seem to feel is not how to get above the speed limit, but how to keep within it, and the papers show, by a daily crop of sad examples, how only too painfully easy it is not to do so.

Nothing points more clearly to what I have indicated as the basis of our instinctive desire for speed, as the fact that our measure of speed is entirely relative. Thus 60 miles an hour would be a slow speed for a motor-car on a racing track, but this speed, which would be even quite good along the open road to Brighton, would be considered decidedly on the high side for motoring along the Strand. Our ideas of what is slow and what is fast are largely derived from habit, and particularly from surrounding conditions and from our mode of estimation. For instance, we have been carried in this hall during the last hour with the surface of the earth round its axis a distance of about 600 miles. But if we judge the speed from observing the apparent rate of motion of the moon and stars overhead, we could never realize this. Far less could we realize by the change in the seasons the speed at which we are traveling with the earth round the sun, accomplishing a distance, as we do, of 540,000,000 miles in 365 days, which represents, roughly, a distance of 61,000 miles per hour. We have thus traveled together, since we came into this hall, a speed of 61,000 miles. But these speeds fall far short of those of certain heavenly bodies with which we are familiar, such as the meteors, some of which are traveling at 160,000 miles an hour, and the recent comet, which probably exceeded this speed one part of its journey round the sun; whereas the fastest speed which man has, up to the present, been able to produce, even in a projectile, amounts to between 2,000 and 3,000 miles an hour (the Krupp 10.7 centimeter having a velocity of 3,291 meters per second, and a 6-inch Vickers, 3,100 meters per second). The highest projectile speeds we have attained are thus only about one-tenth of the speed at which Jules Verne fired M. Barbicane and his friends off, in order to overcome the earth's gravity and reach the moon, since the speed he required was 12,000 yards per second, or 24,000 miles per hour. Such an idea we are quite justified in thinking absurd, but we might have been justified in thinking many of the things absurd which Jules Verne wrote about, only forty years ago, and which have since come to pass. Take "Round the World in Eighty Days." In that case it cost Phineas Fogg £19,000 to take himself and his servant round the world in eighty days. A telephone inquiry of Messrs. Cook an hour or two ago elicited the fact that anyone present can start to-morrow morning and go round the world, with a servant, in less than half the above time, and for less than one-fiftieth of the above sum.

Thus though, impelled by instinct, man will ever continue to strive to increase his speeds of traveling, and with the refinement of machinery and invention doubtless succeed in doing so, it may be safely said that, notwithstanding the still increasing upward angle on some of the speed lines of the charts I have shown to-night, this rate of increase will before long begin to take place at a continually diminishing rate. Such feats as the journey from Paris to London within the hour may be regarded as quite a feasible engineering proposition in the future, though possibly a tube will be used for the purpose, without the employment of wheels, and with a modification of the pneumatic system of that great genius Brunell. We should, however, in doing this journey, be only traveling at half the rate we are actually moving at this spot round the earth's axis, while to do it at the rate we are traveling round the sun, we should only occupy a quarter of a minute.

A New Process of Sewage Disposal

DURING a recent inquiry before the Local Government Board department of the British Government, attention was drawn to the possibilities and economic value of a new process of sewage treatment devised by Dr. Grossman, and recently perfected. Especially in densely populated cities, the question of sanitation and hygiene is of paramount importance to the welfare of the community, and the disposal of the sludge represents a certain outlay showing no economic return.

The town of Salford desired to introduce the new process upon a large practical scale as the result of two years' continuous use of a small plant, which had conclusively demonstrated its value. Dr. Grossman has devoted several years' research and investigation to the problem of the economic recovery of waste products. His system was perfected about two years ago, and the Salford Corporation sanctioned the installation of a small experimental plant at their works to determine its practical value. This plant has been in continuous operation ever since, and authority was sought to permit the installation of a larger scale plant for the treatment of the whole of the town's sewage.

Hitherto this waste product has been handled in the ordinary way, being filtered in clarification tanks so as to permit a pure effluent to be discharged into streams, while the solid matter was pressed and disposed of in the only manner possible. Over 7,000 tons of pressed sludge had to be disposed of annually. From one to two thousand tons were taken over by farmers, to whom it was given free, the agriculturists merely having to defray the cost of transportation, but the balance had to be dumped on a site of land that the town had acquired for this particular purpose. Yet the waste has so little fertilizing value that the farmers hesitated to use it, and certainly will not avail themselves thereof when the transportation distance is very great.

By Dr. Grossman's process everything is sterilized, all living organisms being absolutely destroyed. Moreover, the costly and disagreeable process of filter pressing in order to reduce the bulk of the solid matter is obviated. This operation alone, in the treatment of 7,000 tons, costs Salford $10,000 annually. The fertilizing value of the sludge is nullified by the presence of fats and grease, and in the Grossman method the recovery of these by-products is a salient feature. It is computed that 400,000 tons of soap are used in England every year, and that the greater part of this quantity finds its way into the sewers, so that the heavy proportion of fatty and greasy constituents of the sludge may be realized. The sewage is permitted to settle in the usual manner, and the sediment is passed automatically and continuously into a specially constructed drying machine, whence after all moisture has been driven off it is delivered direct into a retort in its dry state. Here it is mixed automatically with a small quantity of sulphuric acid, and the whole is then subjected to the action of superheated steam.

The result of this treatment is that all the greasy matter associated with the sludge is carried away, to be collected in tanks, and as the fatty acids are present in a large proportion, and command a ready sale, they represent a valuable asset. The residue in the retort is discharged as a fine, dry, brownish powder and free from smell. Being rich in nitrogen, potash, and phosphoric acid associated with humus-like earth, it is extremely valuable as a fertilizer, while, having been sterilized by the superheated steam, it is biologically pure, so that it can be used on the land with perfect safety.

As compared with the pressed sludge system, the new process possesses overwhelming advantages. Labor is reduced to the minimum, since in the Grossman method everything is continuous and automatic, so that there is very little manual operation. Another advantage arises from the fact that the sludge dried in the Grossman machine is so rich in fatty and other combustible substances, that it can be mixed with coke and utilized as fuel for treating further quantities of sludge. When this practice is followed, a cake of sludge that costs 87 cents to produce by the filter-press can be produced by the Grossman method for 18 cents per ton. The commercial value of the fat and grease recovered alone is sufficient to effect a considerable economy in the present mode of sludge disposal.

The experimental plant, which the Corporation has been operating continuously for two years, is of sufficient proportions to deal with one-sixth of the total amount of sludge handled at the works. The manure has been tested on several farms and has given eminently satisfactory results, testifying to the fertilizing properties of the residue after the fatty substances have been extracted. At Salford the sale of the by-products is estimated to bring in $10,000 per 7,000 tons per annum, while the cost of working the plant is estimated at $11,000. But inasmuch as the cost of disposing of the sludge under the present treatment represents an annual expenditure of $7,000 per year, the use of the new system represents a profit of at least $5,000 per annum as compared with the present system. The fertilizer produced by this means will keep indefinitely, and as it is free from odor, it cannot be construed into a nuisance. Even if, in the case of a city, the disposal of the residue was a difficult problem, it could be profitably employed for the purpose of heating further quantities of sewage

An Example of Modern Concrete Construction

A Factory Whose Walls Were Laid Out Horizontally and Subsequently Raised Into Position

We had occasion, some time ago, to illustrate in the Scientific American a rather remarkable method adopted in constructing a concrete church. The walls were first laid out horizontally on the ground, and were subsequently raised into vertical position and assembled into the finished structure. Our illustrations show a factory at Rogers Park, Ill., built by the same method.

The concrete buildings of this establishment are planned with exceptional regard to sanitary conditions, and are fitted with shower baths with perfect ventilation and light. There will be roof gardens provided, and ten city lots are devoted to a park for the comfort of the employees, whose safety is assured by the fire-proof buildings.

There will be three stories and a basement, the building being 40 feet high. The walls are first molded of concrete on a horizontal platform resting on steel jacks, which subsequently raise the completed walls to a vertical position after the concrete has set.

The walls consist of 12-inch curtain walls between 16-inch pilasters spaced on 16-foot centers. To conform with the building ordinance, the first-story curtain walls are 16 inches thick. The 2-foot 8-inch pilasters are reinforced vertically with eight 1/2-inch twisted steel bars. In the curtain walls 3/8-inch round bars are spaced 12 inches apart both ways in both the inside and outside walls. The horizontal bars run through the pilasters. At the corners the rods extend 12 inches beyond the concrete to tie into a 12x12-inch corner piece cast after the side and end walls have been raised. The foundations were built before placing the jacks. The end of the chair supporting the pin around which the walking beam revolves, is placed on the footing. The other end is blocked up from the basement floor. For the sidewalks the jacks were placed 8 feet apart. The worm gearing operating the 9-foot screws, used to raise the slab to its vertical position, was driven by a continuous shaft to which power was transmitted by a belt from a 5 horse-power steam engine.

In erecting the building, the side walls were raised in eight hours. When in position the slab was still supported by the jacks at the toe and back, by planks bolted to upturned angles and by bolts 3 feet apart along each walking beam, fastened to 4-inch pieces of 6-inch channels imbedded in the concrete. The shear on the 5/8-inch bolts and the toe amounted to the total weight of the wall, 250 tons, minus the friction of the concrete on the form.

The slabs were cast within the building with the outside of the walls face up, so that the finishing or ornamental work is all done on the flat, and a coat of waterproofing was applied.

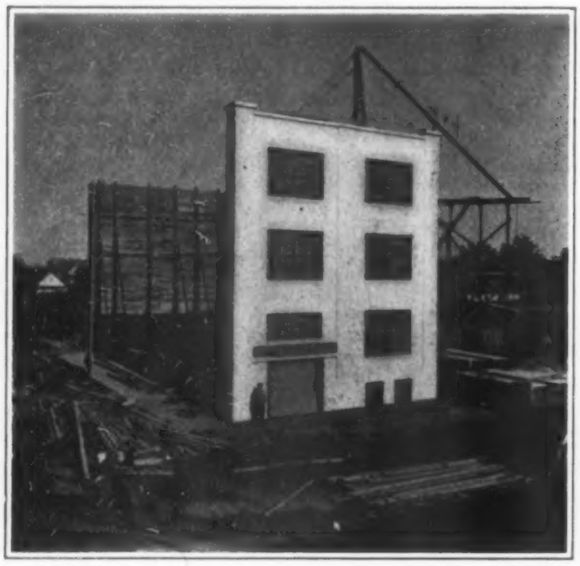
The concrete is mixed throughout in the proportions of 1 part Universal Portland cement to 2 parts sand and 4 parts gravel or broken stone passing a 3/4-inch mesh. The mixer used is set in a pit, so that materials can be dumped directly into it from wheelbarrows.

The unit floor system is used, in which the lower 2 3/8 inches of the 6-inch floor is cast in 3x15-foot slabs in the stockyard, one on the top of the other with building paper between successive slabs. The process is a continuous one. Thirty or more slabs were cast in a single pile. The two hundred required for all the floors in the building were poured in four days and stand in half a dozen piles.

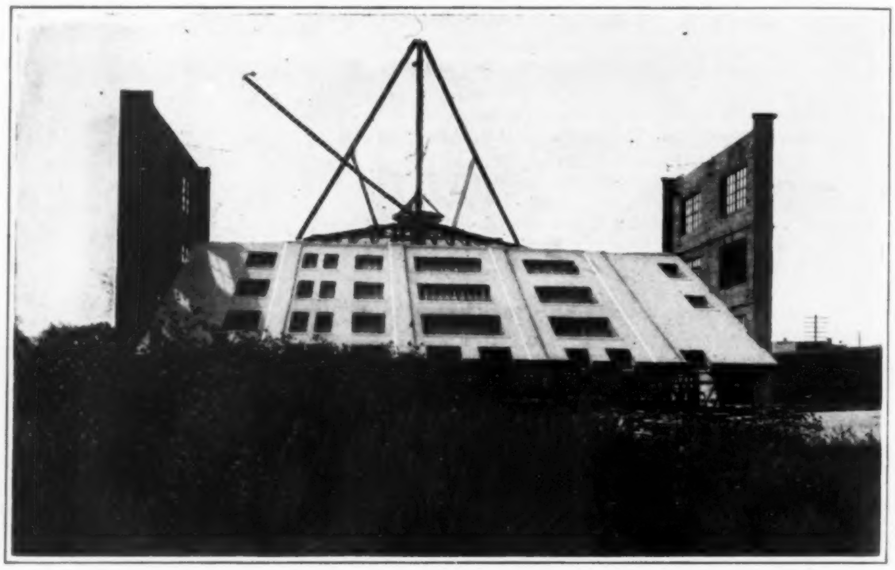
Both end walls were laid out at the same time and raised one after the other, as there was plenty of room within the building lines for the platforms. Only one side-wall could be cast at a time, however, on account of the narrow width of the building. As a protection against overturning action of wind pressure after the removal of the jack machinery supporting the wall, a cable with turn-buckle was run between eyebolts imbedded in the tops of the walls. On the outside two cables were run from the eyebolts to dead men about 50 feet away. Turnbuckles were placed in each cable.

Although the cables were left slightly slack during a severe wind storm which caused a great deal of damage to boats on the lake, the engineers did not note any tightening on the guys. It is estimated to require a wind pressure of 25 pounds per square inch to overturn one of the 250-ton side-walls.

Double walls are used on the ends of the building, with a dead air space of 4 inches between the 4-inch inner and 4-inch outer walls of concrete. The space was obtained by depositing a layer of sand on top of building paper laid over the 4-inch layer of green concrete. Building paper was then placed on top of the sand, and the top or outside of the wall poured. The process was continuous, as no time was allowed for setting. When the end-walls were raised sufficiently, the sand was rodded out of holes left for the purpose in the bottom of the walls. For the side-walls a mixture of coke and enough cement to hold it together was used in place of sand to form the insulation between the two walls.



One of the Side Walls Erected.



Raising the Façade Into Position.

The grooves for partition walls and floors were made in the side-walls by nailing two strips to the platform and filling the space between the strips with sand. Holes for the beam boxes were also filled with sand, placed within hollow forms. Special frames were made to hold the steel window sash in place. A derrick with the 12-foot bull wheel placed 35 feet above ground was used to place the concrete and handle all materials. The 50-foot boom covers the whole area of the building and storage space at the sides of the derrick. The apex of the triangular frame over which the 30-foot mast is erected is placed 15 feet away from the center of the side of the building, leaving space on one side of the frame for the concrete outfit and on the other for a stockyard. The ends of the framework and the apex are all anchored down to 4-foot concrete cubes by cables. The three-drum Mundy hoisting engine handles a load of 4 tons. It is stated that this concrete building cost about 12 cents a cubic foot, including an electric elevator, heating, plumbing, and gas piping.

Fossil Man

It is a striking fact that very few fossil remains of most ancient types of man have been found as yet, so that our knowledge of the origin of our prehistoric ancestors is most imperfect. A remarkable find was the fossil man of La Chapelle-aux-Saints in France, which showed a skull in a remarkable state of preservation. The find attracted much attention at the time, but it remained to be seen what conclusions could be drawn from it. Scientists have been trying to reconstruct our ancient ancestors from this model, but there are many doubts still prevailing. New light is thrown on the subject by the recent work of Profs. Boule and Anthony of Paris, which brought out some striking facts.

As the skull was in a very good state of preservation, they were able to obtain a plaster cast of the inside of the skull almost as sharp and complete as those made from modern skulls. Thus a very good idea could be gained of the shape of the brain, which could not be done satisfactorily in the case of the prehistoric specimens discovered previously, for at best the researches by Dubois on the *pithecanthropus* of Java and by Keith on the remains found at Gibralter were very imperfect.

According to the conclusions reached by Boule and Anthony in their examination, the brain of the individual whose skull has been handed down to us in the fossil remains presents in its general character a type inferior to any known to us among all the races of mankind of the present day. While the volume of the brain is not very far from that of the modern man's brain, in many of its detail structures the organ resembles more closely that of an anthropoid ape. It is long and wide and rather flat, having much the same shape as in the case of the famous Spy and Neanderthal specimens. It is a well known fact that the human brain is in general unsymmetrical in its development, while that of anthropoids is, as a rule, symmetrical. In this respect the newly discovered specimen approaches the human type. At the same time, the convolutions are very much simpler and less finely marked than in the brain of the modern civilized man. Generallly speaking, it may be said that the newly discovered specimen represents a type intermediate between modern man and the anthropoid apes. Thus, for instance, the two lobes of the cerebellum are much separated, somewhat as in the simian brain. In the Australian savage of the present day, the two lobes may be said to display a condition of incipient junction, while in civilized man the lobes are very close. The authors are of the opinion that in spite of the considerable volume of the brain of this specimen, the coarse aspect of the convolutions indicate that the man had only rudimentary intellectual faculties. It appears that the so-called Flechsig's center is only incompletely developed, which would seem to indicate that the individual possessed no articulate speech, or at most only a primitive language. The unsymmetrical structure of the brain, which also appears in the Neanderthal and Spy specimens, but is rare in monkeys, is taken as a sign that the individuals were right-handed, a sign of somewhat advanced specialization.

Machine for Making Wire Netting

Weaving Wire Into Fabric

By Jacques Boyer

Wire netting is made both by hand and by machine, but hand-made netting is no longer used except in cases where machine-made netting cannot be employed, owing to the form of the object to be covered or the shape and situation of the area to be inclosed, for some varieties of window screens mounted on wooden or iron frames, and for other purposes.

In this article only the mechanical production of wire netting will be considered. The wire-drawing establishments deliver the wire in skeins or coils which, in the netting factory, are placed on a conical spindle in a machine by which the wire is wound on bobbins by means of a traveler which moves the wire to and fro over the whole length of the bobbin. The bobbins wound on this machine furnish one of the wires of which the netting is composed. The second wire is wound on another machine in coils which resemble spiral springs and are technically called "springs." These "springs" are made either from wire already reeled on bobbins or directly from the skein, according to the type of netting machine on which they are used. From the "springs" and bobbins the netting is made on the machine illustrated in Figs. 1 and 2 of our frontispiece.

The twisted cable of two wires which forms the border of the netting and gives a stiffness is made on the machine shown in Fig. 3, which can be used for wires of various sizes and delivers the cable wound on spools.

Machines which produce triply twisted netting are of comparatively recent invention, the first patents having been issued in 1853. For 25 years the manufacture was monopolized by the English but a serious competition has recently been developed in France. These machines produce the netting by twisting two wires alternately to right and left, and thus forming meshes from 2/5-inch to 3 inches in diameter.

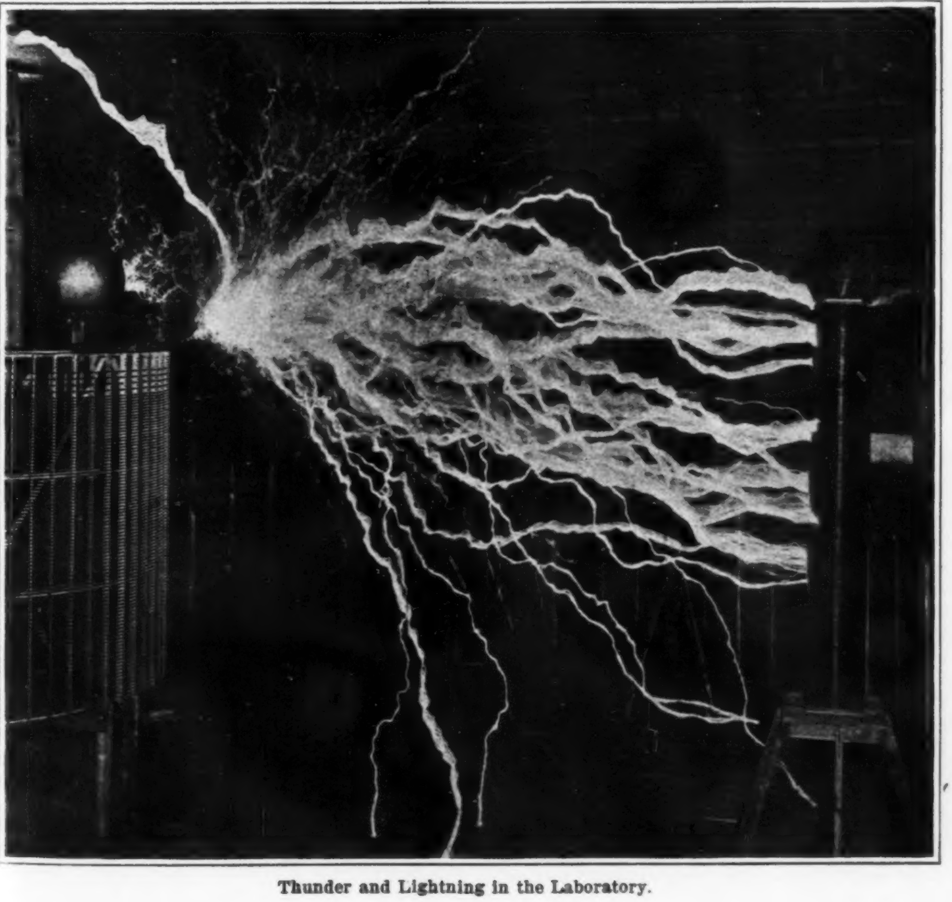
The machine, of massive construction, carries at its front end (Fig. 1) a horizontal shaft on which the netting is wound as it is made. Beneath, on vertical rods rigidly attached to the floor, are pinned spools of wire in greater or less number, according to the width of the netting and the size of the mesh. The spools at each end of the row contain twisted edging cable, instead of single wire. From these spools the wires and cables pass under and around the machine, through combs and between tension rollers, and through holes in pinions, and finally rejoin the second wire which is placed at the front of the machine in the form of the "springs" described above. The ends of the wires are fastened to pegs attached to the collecting shaft at distances corresponding to the size of the mesh. This shaft rotates intermittently, drawing the netting forward by the length of a mesh in each movement, and in each pause the pinions turn and produce a triple twist in the wires. The netting is afterward galvanized in order to fasten the wires securely together and to prevent rusting.

Fig. 4—Machine for Making Barbed Wire Cable.

Fig. 5—Winding the Wire in Coils ("Springs").

Wire netting of this sort is used chiefly for inclosing gardens, poultry yards and the like. For fields and pastures fences of barbed wire are preferred. The barbed wire is really a cable made by twisting together a barbed and a plain wire, both previously galvanized, by means of the ingenious machine shown in Fig. 4.

Netting made by simple weaving, without torsion, is used for window screens and similar purposes.



Thunder and Lightning in the Laboratory.

Lightning Made to Order.

In spectacular effect and impressiveness probably no laboratory experiment surpasses the performances of a Tesla high-frequency current. The torrents of streamers (the word "spark" is utterly inadequate as applied to such discharges), which pour forth from the apparatus, rending the air and sending out a deafening and nerve-racking roar, baffle description, and must be seen to be properly appreciated. Next best to an actual experimental demonstration is a pictorial representation such as that which accompanies this note, and which is derived from the French journal "L'Illustration." An idea of the giant size of the discharge is obtained by observing the seated figure of a man in the background.

A rather remarkable feature about these high frequency discharges is that their bark is worse than their bite. A seemingly very heavy discharge can be received and passed through the body without any harm at all, provided that the point at which the spark strikes is not the bare skin but a piece of iron or some similar article. The explanation usually given for this, is that very high frequency currents are not conducted through the entire cross section of a conductor, but only over the surface, by virtue of the so-called skin effect. Those who are familiar with alternating currents know that the obstacle offered to them by a given body depends not only on ohmic resistance, but on the so-called impedance, and to this fact is due the effect observed with high frequency disturbances, that the path which they select is not by any means necessarily that presenting a minimum of ohmic resistance.

This subject has been very lucidly discussed by Prof. Slaby, in an article which was reproduced in the Abstracts from Current Periodicals, on page 623 of the issue of June 24th, 1911, of the Scientific American. To this abstract we refer those of our readers who wish to extend their information on the subject.

Absolute and Theoretical Depreciation*

A Question of Industrial Economics

In a paper on depreciation as related to electrical properties, which Mr. Henry Floy read before the American Institution of Electrical Engineers at its Chicago convention, he made a distinction between absolute and theoretical depreciation, which he regarded as of much importance in appraisal work.

At the outset it was pointed out that where property is no longer of any service it must, of course, be depreciated down to its selling value, even though that is only its scrap value. On the other hand, apparatus in use and operating economically may be as valuable for the immediate purpose as when first installed, although nearly at the limit of its life. A well-maintained but old engine is an example of this; its "service value" may be as great as when it was first put into operation. What is meant by depreciation in these cases, Mr. Floy explained with the aid of the accompanying diagram of the ways in which depreciation actually takes place and those in which it is assumed to occur.

Assume that the object has an estimated life of 20 years, represented by the abscissa OB, and that it has a value represented by the ordinate OA. The ordinate OC is assumed to be the scrap value of the apparatus, and the line CD gives the scrap value throughout the life. Its deviation from a straight line will be due to the fluctuations in the value of scrap. The point D is the scrap value at the end of its life, and may be reached by every one of the six curves.

Curves 1, 2 and 6 Mr. Floy considers representative of "absolute depreciation," and curves 3, 4, and 5 representative of "theoretical depreciation." Curves 1 and 2 represent the values of most objects during any period of their lives, because the market value of new apparatus depreciates rapidly for some time after being installed, and later falls off more slowly. Curve 1 represents the conditions with special machinery for a given purpose and property expensive to remove, like track material. Curve 2 represents the conditions with property easily removed, like rolling stock. These classes of depreciation might be termed salvage values, and approximate scrap values, the principal difference being that the property is sold for what it is worth as a unit rather than as dismembered parts. Mr. Floy contends that depreciation of these classes cannot fairly be used in determining the value of physical property of an operating entity.

Curve 6 indicates only depreciation due to wear and tear until just before the close of life, at which time other classes of deterioration may appear. The curve is based on the assumption that the apparatus in question will be used in connection with the purpose for which it was installed throughout its life, and being maintained in good operating efficiency is just as good for the purpose of use as on the day it was installed, except for such slight deterioration as results from wear and tear. The worth represented by this curve, 6, may be called the "service value," and it is the real value of its physical property to a "going concern." Most classes of apparatus or property of a going organization follow this curve 6, unless affected by inadequacy, obsolescence or deferred maintenance.

The value of the physical property, as indicated by curve 6, is that generally allowed in "purchase and sale transactions," and has been recognized by Public Service Commissions.

"If the present value exclusively were to be taken as the basis, respondent would not receive credit for having installed any part of its plant at full cost. The present value, as of June 30th, 1908, must, therefore, be increased by the amount of the estimated depreciation on that part of the plant which the company installed new." F. B. L. Fullmer v. Wausau Street Railroad Company, Railroad Commission of Wisconsin, April 1st, 1910.

"Of the physical plant alone, the most equitable valuation for rate-making purposes appears to be best represented by the original cost of the plant and by the cost of reproducing it." G. W. Hill et al. v. Antigo Water Company, Railroad Commission of Wisconsin, August 3rd, 1909.

"This 'service value' would seem to be recognized by the courts both in rate cases and in determining valuations for sale." City of Omaha v. Omaha Water Company, 218 U. S., decided May 31st, 1910. Wilcox v. Consolidated Gas Company, 212 U. S., 19.

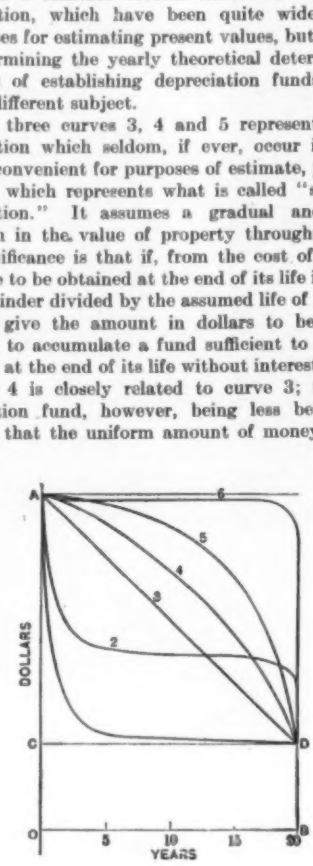
"Probably a fair statement would be that the physical value of the plant is its value as a performing plant for the purposes for which it was designed." Columbus Railway & Light Company v. City of Columbus, Circuit Court U. S., Southern District of Ohio, report of master.

If any contrary position were assumed, namely, that only "sales value," indicated by curves 1 and 2, were to be used in determining present value, then a large portion of every going property would be valueless, because the expense of removal would amount to more than the cost of new in the open market; for example, ties in a railway property, foundations and settings for machinery, pipe deeply buried, crossarms and many wooden poles.

In contradistinction to determination of present value by the use of depreciation expressed in the curves 1, 2 and 6, which may be termed "absolute," the curves 3, 4 and 5 indicate several classes of "theoretical" depreciation, which have been quite widely used in some cases for estimating present values, but more often for determining the yearly theoretical deterioration for purposes of establishing depreciation funds, which is quite a different subject.

These three curves 3, 4 and 5 represent classes of depreciation which seldom, if ever, occur in practice; but are convenient for purposes of estimate, particularly curve 3, which represents what is called "straight-line depreciation." It assumes a gradual and constant reduction in the value of property throughout its life. The significance is that if, from the cost of apparatus, the value to be obtained at the end of its life is deducted, the remainder divided by the assumed life of the apparatus will give the amount in dollars to be laid aside annually to accumulate a fund sufficient to replace the property at the end of its life without interest.

Curve 4 is closely related to curve 3; the annual depreciation fund, however, being less because it is assumed that the uniform amount of money laid aside



Depreciation Curves.

annually during the life of the property will be put out at interest and compounded, so that owing to the accumulation of interest the amounts annually laid aside will be less than in the case of "straight depreciation." Curve 4 is called the "sinking-fund" method.

Curve 5, a modification of curve 4, is based on the assumption that instead of laying aside a regular amount annually and compounding, the amount laid aside will be small at first, gradually increasing in amount as the earning power of a property increases, as it generally does, with its life. These amounts are then assumed to be put out at compound interest so as to aggregate the original cost of the apparatus at the end of its life. No general rule has been developed as to the proper amounts to begin laying aside or in what proportion they shall increase; but it is clear that the smaller are the amounts in the beginning, the larger must they be toward the end of the life of the apparatus.

This latter plan of providing depreciation funds has the advantage of more nearly proportioning the annual depreciation payments in accordance with revenue, and for most pieces of property will more clearly approximate the deterioration actually taking place, Mr. Floy states.

A fourth plan of determining "theoretical" depreciation has been used to a limited extent. It consists in assuming a given life for the property in question, ascertaining the annual rate of depreciation and then applying that rate uniformly to the principal diminished in amount each year by the deduction for deterioration. For example, if the principal invested were $2,000 and the rate assumed is 10 per cent, the amount charged off for depreciation the first year would be $200, leaving the principal, $1,800, on which 10 per cent or $180 would be charged off the second year, and $162 the third year, etc.; thus the amount charged off becomes progressively less and the life of the property becomes theoretically, at least, infinite. Of course, this method can be modified from the "straight line" depreciation illustration used above to the "sinking fund" method, if desired.

Any one of these four methods of estimating depreciation is based on absolutely arbitrary assumption. Practically there is no more logical reason why we should provide the fund necessary to replace the property at the end of its life by any one of the several methods suggested by the curves rather than by any other of the several methods. Each method will accomplish the same result, but it will be seen at a glance that in applying curves 3, 4 or 5, the amounts to be laid aside annually will vary considerably, and to that extent affect net income; similarly, the effect on the worth of the owner's investment will also vary with the curve used, being appreciably less for "straight line" depreciation. Where the lives of the property considered are relatively short the result of using any one of these three curves is less pronounced; but where the lives are long, running to 50 or 100 years, the difference for the major portion of their lives is marked. The fourth plan suggested has not the advantage of being sound theoretically or advantageous practically.

The "straight line" method of depreciation has been more largely used than any other, probably because the life of much apparatus is brief, and, furthermore, the application of this method is the most simple, direct and easily understood, and hence favored by the legal fraternity and a large proportion of the members of public utility commissions, many of whom, not technical men, naturally incline toward the more easily appreciated elements of the questions which they are compelled to consider.

There are three other methods of determining the depreciated value, that is, the present value, of physical property, which Mr. Floy mentioned.

The first consists in estimating the cost of purchasing and installing second-hand or used apparatus of the type and character of that installed and equivalent for the same work. The difficulty of carrying out this method in practice is the impracticability of finding duplicate used apparatus and obtaining fair or uniform standards for determining the price which should be placed on it.

Some authorities claim, as another method, that the depreciated value of a plant should be determined by comparison with the cost of a most modern installation designed to do the same work. This method has apparently received some encouragement from the courts. A third method of ascertaining present value is to make an estimate of the cost of reproducing the physical property new and deducting therefrom the estimated expense of putting the existing property in a condition equal to new. None of the three methods just mentioned above is generally favored.

As indicating the possible error in attempting to estimate "theoretical" depreciation, it is frequently found that the length of life assumed has been greatly surpassed by apparatus which is still giving reliable and satisfactory service. For example, the life of the ordinary steam engine may be taken at 20 years, but it is not uncommon to find engines still in use that are very much older than this. A vertical engine installed in England in 1856 has recently been equipped with condenser, supplied with super-heated steam, and is still in use at fifty-five years of age, giving economical and satisfactory results. Cases of this kind will illustrate the necessity for personal inspection in determining depreciation and the need of experience and common sense in the application of any rules of depreciation. For apparatus still giving satisfactory service after the expiration of its assumed life it is only fair in estimating theoretical depreciation to allow a value greater than that which it would be worth as scrap.

* Reprinted from *Engineering Record*.

Fire-proof Starch (made without changing its whiteness).—Over 10 parts of white burned and pulverized bones are first poured 50 parts of hot water, then gradually 6 parts of "English" sulphuric acid are added. The well-stirred mixture is left for two days in a warm place, stirring it occasionally, then, after the addition of 100 parts of distilled water, filtered. To the fluid is next added 5 parts of sulphate of magnesium (Epsom salts) previously dissolved in 15 parts of distilled water, then, while cold, as much ammonia (spirits of salammoniac) added as will cause the fluid to smell of it, the separated precipitate filtered through a linen cloth, dried in a moderately warm place and reduced to a fine powder. Of this two parts, with 1 part tungstate of soda and 6 parts of wheat starch, are thoroughly mixed and a little blue carmine added. For use mix the powder with double the quantity of water and add as much boiling water as will produce a viscid fluid in which the objects to be starched are immersed

Machine Molding.*

Labor and Time Saving in the Foundry

By Wilfred Lewis, M. E.

Although modern industry depends upon the foundry for a large part of its products and the ingenuity of inventors has been busily engaged for generations in the evolution of labor-saving machinery, very little of this effort has been devoted to the improvement of the foundry itself, and it is only within comparatively recent years that machine molding has developed much importance as an art. In the year 1800 an English patent was granted for molding screws, the patterns for which were backed out of the sand by lead screws of the same pitch. This was simply a pattern drawing machine of rather ingenious construction, but the English records do not touch again upon machine molding until 1839, when a very similar patent appears. From this time forward more interest seems to have been aroused and these patents were soon followed by others for packing sand by mechanical means, including hydraulic cylinders, stampers and rollers of the road-roller type. Machines for molding gears and pipes also appear in the first half of the nineteenth century, and in 1843 we find an American patent on the molding of cannon balls. Later, in 1869, the first jarring machine patent was taken out, and it is not proposed to give a history of the art of machine molding from patent office records but simply to point out that the art began in a small way on bench work and continued chiefly in its application to small molds that one or two men could handle until the end of the last century. Larger work was not generally regarded as applicable to machine molding until the jarring machine began to emerge from a long period of obscurity and demonstrate its peculiar fitness for ramming large bodies of sand. Its development for large work belongs mainly to the present century and through its means the art of machine molding has been extended to embrace nearly everything molded in sand. But there are, of course, exceptions and peculiar difficulties which will always depend upon the molder's skill for their proper execution, with or without the aid of machine, and like any other equipment the installation of molding machines must depend upon the saving to be effected by their use and the outlay needed to effect that saving. This leads at once to the consideration of foundry costs, the analysis of which should point the way to their reduction. These costs are made up of many important elements beyond the scope of the subject, and the effect of one item only need be considered, that of machine molding, leaving all other items to be treated in the same way by those who are interested in attaining the highest efficiency in every detail of operation.

Machine molding began, as has been said, on small work and probably one of the best known appliances is the little hand squeezer. This is a very simple and effective machine designed to save part of the time consumed in ramming. Fig. 3 is a little power squeezer adapted to the same class of work as the hand squeezer which saved the work of ramming but put upon the operator the work of squeezing. There the man still did the work but with greater despatch, and therefore more efficiently. Here the machine does the squeezing and the operator is less fatigued and can work faster. In support of this statement the floor shown in Fig. 4 may be offered as evidence.

Here 270 molds have been put down by one man in six hours and it is stated that this daily performance has recently been increased to 325 in the foundry of the American Hardware Corporation, where nearly 100 machines of the same type can be seen at work. Of course these performances by expert operators are not to be expected along the whole line, where the average may be in the neighborhood of 200 molds a day, but they show what is possible, if not always probable, and it remains to be seen how a proper day's work on any given pattern can be fairly estimated. We are frequently asked to say what the machines will do and what production we will guarantee, regardless of the fact that we never know anything about the man operating the machine and seldom very much about the patterns to be used, the cores to be set or the precautions found necessary to insure success in molding the same patterns by hand. We know in a general way the type of machine required, but until we have actually made molds and poured castings, we are at a disadvantage and cannot safely guess at results which should be determined from a careful analysis of the experience gained in molding by hand. The foundryman contemplating the introduction of machines has had the necessary experience, but he seldom, if ever, has it in a shape available for analysis, and the importance of making observations in detail and recording the time required for each and every step taken in the production of a mold will be shown. This has been brought out very forcibly by Mr. Knoepple in the April number of the *Engineering Magazine*. The suggestions there made are in line with the practice of the Tabor Manufacturing Company for the last five or six years, but the matter is one that has only begun to receive the attention it deserves as an important feature of scientific management. Consider, for example, a set of patterns mounted in a vibrator frame 13 inches by 17 inches for use on a squeezer. They can be molded either by hand or by power, but if we mold them by hand and note down the time taken by every step in the process we shall see where to look for a saving and what to expect when molded by power.

Fig. 1 shows the result of observations taken on molding by hand by an experienced man with a stop watch. The time is taken in minutes and hundredths for convenience in summing up. Items 4 to 11 inclusive have to be done in the same way and will consume the same time, 0.45 minute, whether the mold is made by hand or by power, as will appear in Fig. 4.

Item 12 must be done more thoroughly and takes more time when the mold is completed by hand.

*Reproduced by courtesy of the editor of the *Journal of the Franklin Institute*, from a paper presented at a meeting of the Mechanical and Engineering Section.

DM11 INSTRUCTION CARD FOR OPERATION SYMBOL

Sheets, Sheet No.		Drawing No.	H'nd Mol'g	Order No.	
Material	Class No.	Pieces in lot	Time for lot	Bonus	

Description of Operation. Molding Drag and Cope. (Part of Plow.)
Shown in Bulletin M. R. January 1st, 1911. (Page 8.)
Flask 13″ × 17″ 4″ Drag, 4½″ Cope Hand Molding at Bench.

Item	Detailed Instructions	Feed	Speed	Element time per piece	Time for entire lot	Continuous or running time
1	Preparation					
2						
3						
4	Pick up nard sand match and put on bench			0.04		
5	Pick up pattern and put on hard sand match			0.04		
6	Pick up drag and put in place			0.07		
7	Shake parting on pattern			0.08		
8	Pick up riddle and put on flask			0.02		
9	Fill riddle with sand. One shovelful			0.04		
10	Riddle sand on pattern			0.08		
11	Fill drag with sand. Three shovelfuls			0.08		
12	Pein around edge of drag and butt ram some (with shovel butt)			0.10		
13	Put two more shovelfuls in drag			0.06		
14	Butt ram			0.30		
15	Strike mold off with bar 3/8 × 1 × 36 long			0.10		
16	Pick up bottom board and place in position			0 08		
17	Roll mold over			0.08		
18	Remove hard sand match			0.07		
19	Blow sand off of mold (with bellows)			0.07		
20	Repeat operations 6 to 10 incl. for cope			0.29		
21	Fill cope with sand. Four shovelfuls			0.10		
22	Repeat operations 12 to 15 incl. for cope			0.56		
23	Mark sprue hole (with cope board)			0.05		
24	Cut sprue hole			0.12		
25	Rap pattern. Spike going through sprue hole into pattern			0.48		
26	Round sprue			0.10		
27	Remove cope mold			0.09		
28	Blow pattern off with bellows			0.09		
29	Draw pattern from mold by hand			0.45		
30	Patch up mold (with slick)			0.30		
31	Close mold			0.12		
32	Remove snap flask from mold			0.07		
33	Remove mold to floor			0.07		
34						
35	Number 4 riddle.			4.20		
36						
37	Weight of shovel, 5 lbs.					
38	Weight of sand, 16 lbs.					
	Total weight, 21 lbs.					
	When machine cannot be run as ordered machine boss must at once report to man who signed this card.	4 Month	19 Day	11 Year	Signed DVM	Checked

Fig. 1—Time Record of Molding by Hand, Experienced Operator.

DM 11 INSTRUCTION CARD FOR OPERATION SYMBOL

1 Sheets, Sheet No. 1		Drawing No.	Machine No. M 10 32 R	Order No.	
Material	Class No.	Pieces in lot	Time for lot	Bonus	

Description of Operation. Molding Drag and Cope. (Part of Plow.)
Shown in Bulletin M. R. January 1st, 1911. (Page 8.)
Flask 13″ × 17″ 4″ Drag, 4½″ Cope. Power Squeezer.

Item	Detailed Instructions	Feed	Speed	Element time per piece	Time for entire lot	Continuous or running time
1	Preparation					
2						
3						
4						
5	Pick up hard sand match and put on table of machine			0.04		
6	Pick up pattern and put on hard sand match			0.04		
7	Pick up drag and put in place			0.07		
8	Shake parting on pattern			0.08		
9	Pick up riddle and put on flask			0.02		
10	Fill riddle with sand			c.04		
11	Riddle sand on pattern			0.08		
12	Fill up drag. 3 shovelfuls			0.08		
13	Pein around edge of drag. (Butt of shovel.)			0.05		
14	Strike off with board and put in place			0.07		
15	Bring yoke over and squeeze. 60 lbs. pressure			0.06		
16	Roll mold over. (On table.)			0.08		
17	Start vibrator and remove hard sand match			0.03		
18	Blow off with compressed air			0.05		
19	Repeat operations from 7 to 11 inclusive for cope			0.29		
20	Fill up cope. 4 shovelfuls			0.10		
21	Repeat operations 13, 14 and 15 for cope			0.18		
22	Remove cope board			0.03		
23	Blow mold off with compressed air			0.05		
24	Cut sprue hole			0.08		
25	Start vibrator and lift cope			0.12		
26	Blow mold off with compressed air			0.05		
27	Start vibrator and draw pattern			0.10		
28	Close mold			0.12		
29	Remove flask			0.07		
30	Stop off carrier			0.06		
31	Place mold on floor			0.06		
32						
33				2.10		
34	Number 4 riddle					
35						
36	Weight of shovel 5 lbs.					
37	Weight of sand 16 lbs.					
38	Total weight, 21 lbs.					
	When machine cannot be run as ordered machine boss must at once report to man who signed this card.	4 Month	20 Day	11 Year	Signed DVM	Checked

Fig. 2—Time Record of Machine Work, Same Operations as in Fig. 3.

Item 13 is not required for machine molding.

Item 14, butt ramming 0.30, is equivalent to squeezing by power, but it takes five times as long.

Item 15, striking off, is performed after ramming and takes 0.03 longer than striking off the unrammed sand on the machine.

Item 16 is not required in machine molding.

Item 17, rolling over, is the same in both cases.

Items 18 and 19 take 0.14 minute and only 0.08 minute when compressed air is used on power machine.

Items 20 and 21 are the same for hand or power molding.

Item 22 shows 0.56 minute by hand against 0.18 by power.

Item 23 is not done by power as a separate operation.

Item 24 is the same in both cases.

Item 25 to rap pattern takes 0.48 minute against 0.12 minute to start vibrator and lift cope at one operation on machine.

Item 26 is the same in both cases.

Item 27, remove cope, takes 0.09 minute.

Item 28, blowing off pattern with bellows, takes 0.04 longer than with compressed air.

Item 29, drawing pattern, takes 0.35 minute longer.

Item 30, patching up 0.30 minute, is not called for on machine.

Item 31, 32 and 33 are the same in both cases; in molding by power an additional operation, stopping off carriers 0.06 minute is required.

Fig. 2 shows the operations in detail for molding the same patterns on the machine. There are thirty operations by hand footing up 4.20 minutes and 27 operations on the machine footing up 2.10 minutes, making the machine time just one-half of the time required when molding by hand without the use of compressed air.

It is also apparent from a study of these time-tables that the use of compressed air alone instead of bellows will effect a saving and that the vibrator in connection with hand molding will also effect a greater saving. Making the necessary substitution in Fig. 1 for the use of blower and vibrator it will be found that this additional equipment alone would reduce the molding time from 4.20 to 3.06 minutes. It, therefore, appears that the blower and vibrator can be used to save 1.14 minutes per mold and the squeezer 0.96 minute more. This looks as though the blower and vibrator alone saved so much that it might not be worth while to put in the machine, but if we look again at the increased production, taking hand work as the basis for comparison, we see

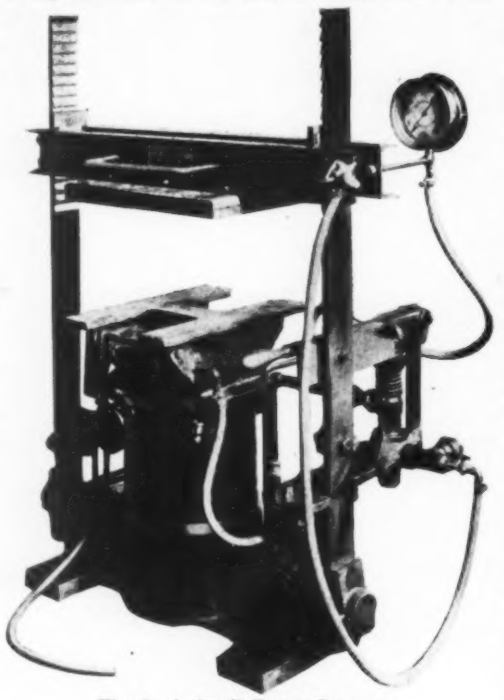


Fig. 3—A Small Power Squeezer.

that the output from the use of the former is $\frac{4.20}{3.06}$ or 1.38, while from the use of the latter it is $\frac{4.20}{2.10} = 2$, that is an increase of only 38 per cent on hand work against 100 per cent on machine work.

But it may be argued that another element of time remains to be considered, and it must be admitted that no account has yet been taken of the time required to distribute a large number of molds on the floor. I do not know how far a mold can be carried and placed on the floor in 0.06 minute, the time noted, but this time should be taken to about the middle of the space to be covered, and perhaps some additional time be allowed for this item, but on the other hand it may be said that no allowance has been made for the inexperience of the operator, who was in this case a pattern-fitter and not a molder or demonstrator. The time given will vary with different men, and it was taken in these cases simply for the purpose of illustrating the method by which important conclusions can be reached. No better data can be obtained for fixing prices, and when time is taken by an observer of experience who understands his business the stop watch never runs unless useful work is being done in the right way. A reasonable allowance should always be made for contingencies and a bonus put upon the performance of the work specified in the allotted time.

When patterns are cast in an aluminium match plate both cope and drag can be squeezed at the same time, the number of operations on the machine is reduced from 27 to 25 and the total time from 2.10 to 1.76 minutes.

The snap flasks used are of the usual type, and in these experiments about the same size, in this case 12 inches by 17 inches, 4-inch cope, 4½-inch drag. The machine will squeeze molds as large as 14 inches by 20 inches, but the best production can generally be realized on smaller sizes.

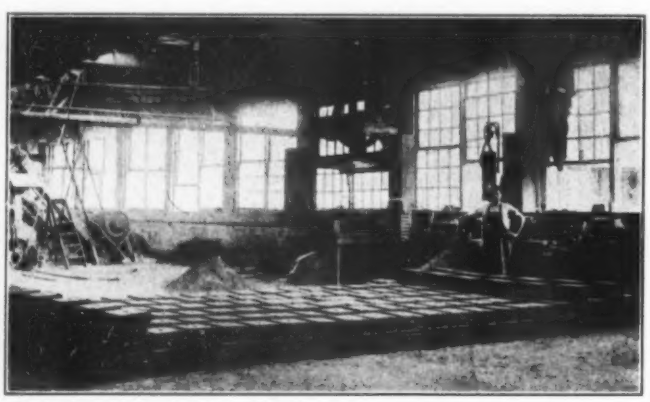


Fig. 4—This picture shows 270 molds made by one man in six hours by the aid of the power squeezer of Fig. 3.

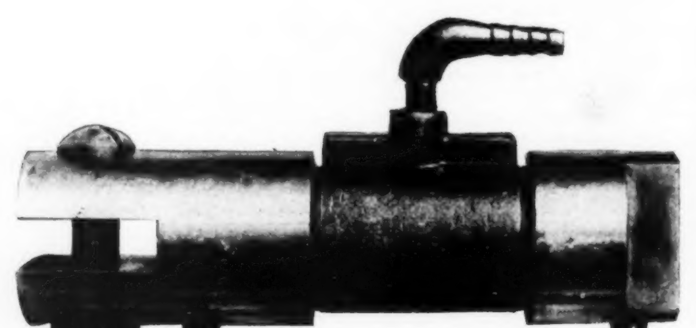


Fig. 5—The Tabor Vibrator.

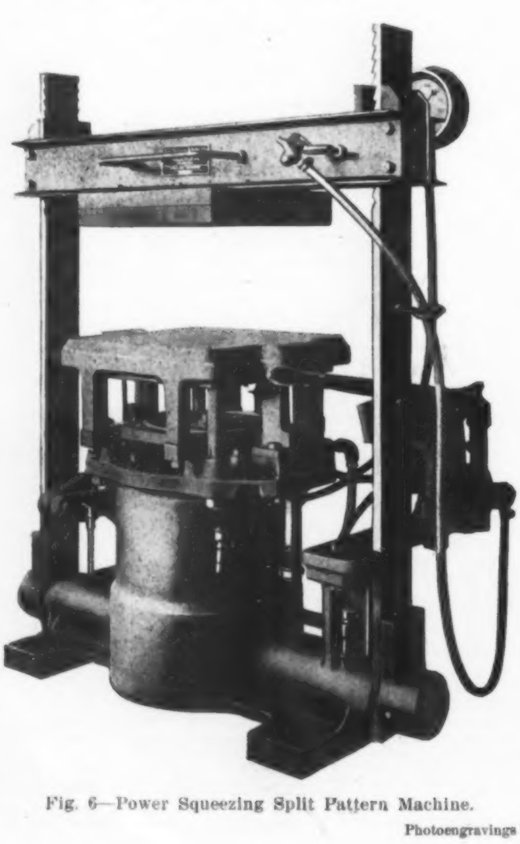


Fig. 6—Power Squeezing Split Pattern Machine.

Fig. 7—In this machine the pattern is lifted off the mold.

Photoengravings by courtesy of the Secretary of the Franklin Institute

Fig. 8—This machine rolls over and draws the pattern by means of a cylinder and plunger.

Fig. 9—Shockless Jarring Machine. Details of Construction are shown in Fig. 12.

Instead of the aluminium match plate, patterns may be mounted on a steel plate, and when split or flat back this is a very convenient method.

They may also be mounted on a paraffined board held in a vibrator frame, and when so arranged the molding time is substantially the same as for the aluminium match plate mounting.

Fig. 5 shows the Tabor vibrator, to which a large part of the saving effected by compressed air, with or without a power squeezer, is due. Power squeezers are made in various sizes, but the smallest size covers by far the largest field. It has been imagined that by increasing the size of flask and putting in more patterns greater production can be obtained, but this is seldom the case, and as previously mentioned the greatest output comes from medium-sized flasks easily handled by one man. Fig. 6 illustrates a small power squeezing split pattern machine with power draft. Machines of this type can be used with or without stripping plates and are applicable to a great variety of work made in solid or snap flasks. There is less handling time on this machine than on the power squeezer, and since each half of the mold is made separately the strain on the operator is not so great.

It is also possible to cope off, by means of supporting stools, pockets of hanging sand that would be impracticable on a squeezer. It is a very fast machine, but no illustration is as yet available to show where it gains on the squeezer by reducing the number of operations required and the total molding time. There are some jobs, however, which can be made as quickly on one machine as on the other, and although this is a much higher class of machine than the squeezer it does not follow that it is better for every purpose.

On such machines the cope and drag are frequently made from the same set of patterns, and it is therefore a matter of first importance to have them so located on the pattern plate as to match perfectly when the mold is closed.

Split pattern machines have been on the market for many years and their value is recognized and appreciated, but unfortunately they have to be built for a flask of fixed dimensions or at least fixed in length or width to fit the flask pins on the machine. They are expensive to build, rather inflexible in their application, and within the last few years they have been superseded very largely by roll-over machines with straight pattern draft to ram by hand or by power. An ingenious hand-ramming roll-over machine, with mechanism for rapping the pattern carrier and dropping the flask from the pattern, was brought out by Teetor in 1889, in which plated patterns are carried in a roll-over frame to which the flask is clamped and rammed in the usual way by hand. When rolled over, a support beneath is brought up by a hand lever, the flask is unclamped and the pattern rapped by turning a hand wheel on the trunnion shaft. At the same time the pattern is drawn by lowering the flask. A few of these machines can still be found in use, but the rapping mechanism is not durable, the machine is rather limited in its scope and other types have displaced it for some time.

The French machine of Bonvillan & Ronceray is a modification of this type, in which the outer trunnion is omitted and power is added for squeezing the mold and drawing the pattern. This will be remembered as having been exhibited at the Foundry Convention held in Philadelphia in 1907. It has a number of attractive features and is said to be very successful in France, where hydraulic power is more popular than it is here, but the machine has not been so successful on this side of the Atlantic, and it is doubtful that water can compete with air as a working fluid for foundry use.

The advantage of rolling over to draw a pattern is well known and in some cases it is an absolute necessity. This has led to the development of a large number of roll-over machines, nearly all of which drop the mold away from the pattern after the manner of Teetor. The one exception is shown in Fig. 7, and this lifts the

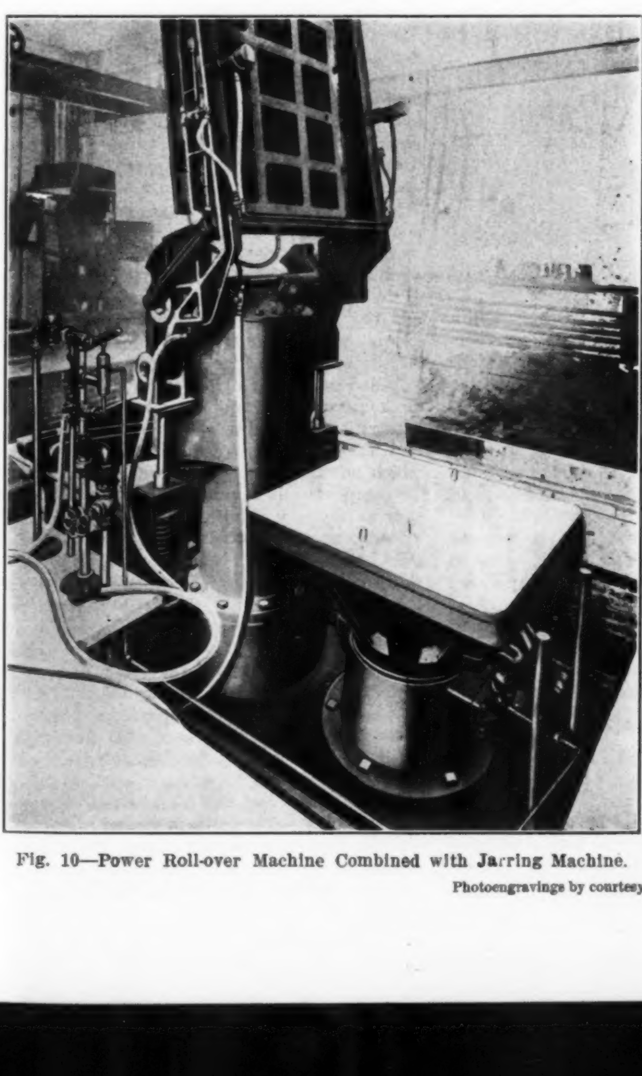


Fig. 10—Power Roll-over Machine Combined with Jarring Machine.

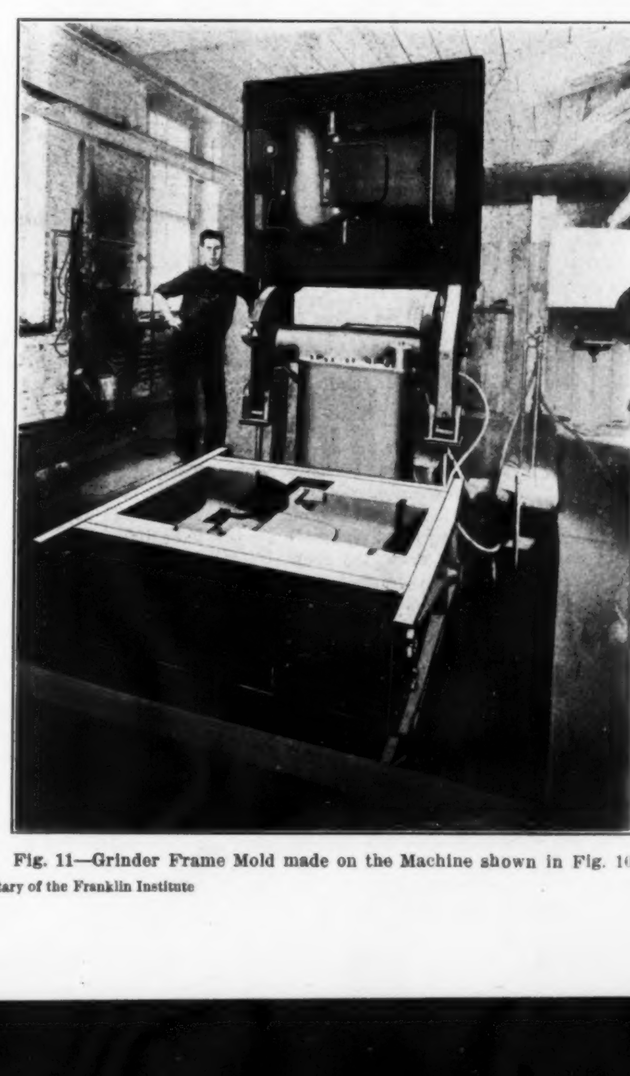


Fig. 11—Grinder Frame Mold made on the Machine shown in Fig. 10.

Photoengravings by courtesy of the Secretary of the Franklin Institute

pattern from the mold in what is generally admitted to be the logical way. Logical because the pattern is generally lighter than the mold and consequently preferably the part to be manipulated. The machine illustrated is shown as fitted with a grate bar pattern having 140 deep pockets, into which the sand is thrown by hand or settled by jarring the swing frame against its stops before ramming in the usual way by hand. Throwing the sand by hand is preferred, because the jarring process is not uniform and naturally varies with the distance of different parts of the pattern from the turning center.

The flask used in this case is 14 inches by 37 inches by 5 inches deep and the time required for a complete cycle of operations was 5.81 minutes. The cope for this grate bar is almost flat and requires no machine. It could be made by a helper who would have time enough to spare to assist in rolling over, and probably eight to ten molds an hour could be made by experienced men.

In this machine, which takes a flask 24 inches wide and has 7-inch pattern draft, the swing frame and sliding head are counterbalanced by helical springs. These

Such machines may be fitted with long patterns overhanging the swing frame for a considerable distance at each end. This possibility indicates the scope of the machine and the advantage of rolling over about an axis parallel to the length of the flask instead of about a normal axis as is done on machines of the French type.

Time study on large work may show that a material saving is effected in finishing, in ramming or in both, and where ramming time is the principal item a jarring machine is the equipment most needed to reduce costs. There are quite a number of jarring machines on the market, all of them covered by the original claim of Hainsworth in his patent of 1869, which is so refreshing for its simplicity and breadth that it is worth quoting:

"The packing of sand, for a mold, in a flask, by raising the same, together with the pattern, and letting them all drop upon a hard bed, substantially as shown and described."

There were no permutations and combinations of elements making an extended series of claims calculated to exhaust the patience of the reader. All he wanted was the whole field and he secured it in a single claim,

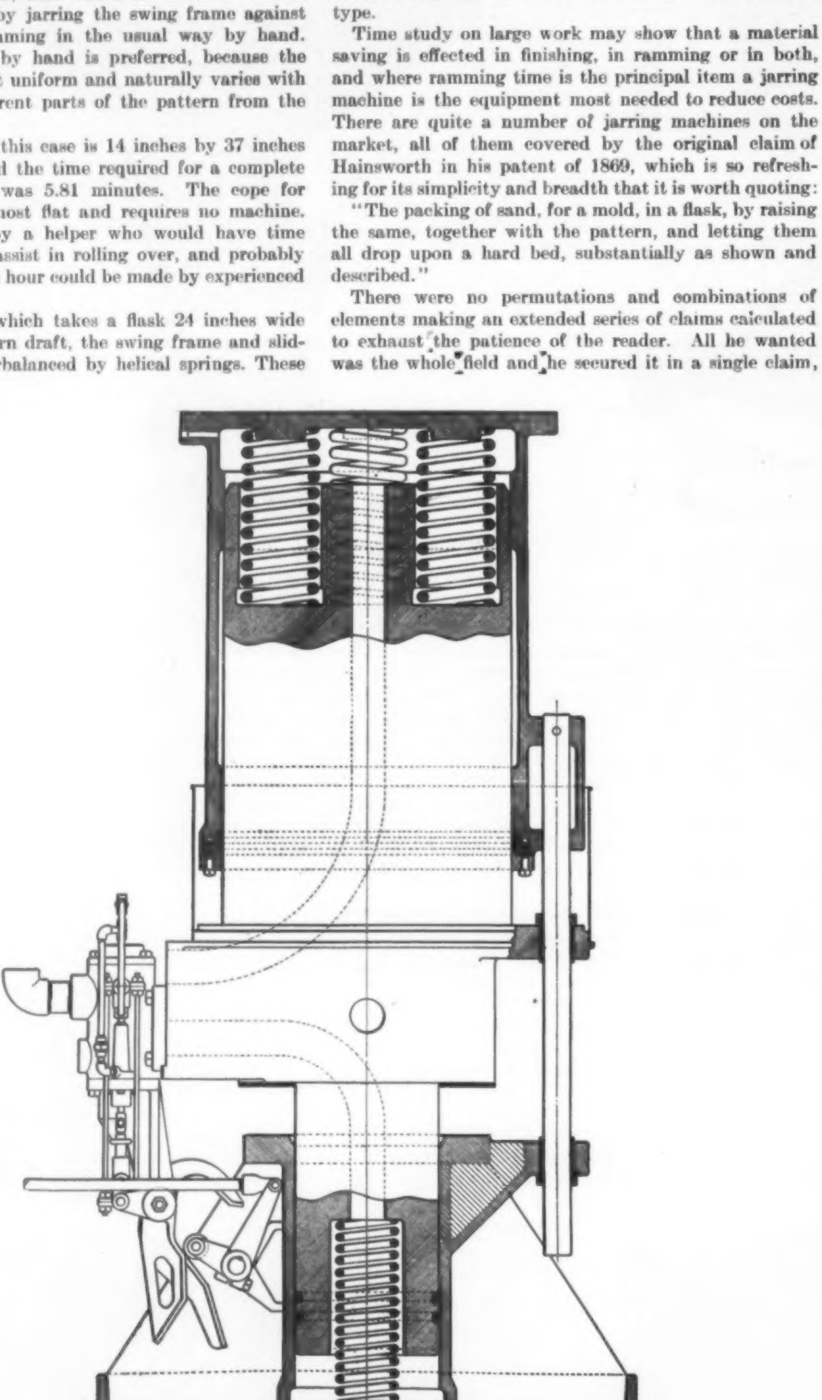


Fig. 12—Sectional elevation of the Shockless Jarring Machine.

can be adjusted to the weights to be carried and the pattern is drawn by a hand lever at one side.

Since the weight that can be conveniently rolled over by hand is limited to three or four hundred pounds, heavier molds naturally require power, and in Fig. 8 we have a machine which rolls over and draws the pattern by means of a cylinder and plunger, using compressed air on hydraulic oil or water to effect the movements.

The illustration shows the pattern drawn and rolling back into position for another flask. In these machines a vibrator is attached to the swing frame and this materially assists in making a perfect draw, the main object of these roll-over machines. They are designed to save pattern drawing and finishing time, and where patterns are of such a character that the margin for this saving is small the time study will show it and possibly suggest a jarring machine instead. But molding machines do much more than save time in molding and are often worth all they cost in the saving of patterns, the saving in metal and the saving in machine work by reason of the greater uniformity and closer finish of the castings produced.

An important feature of these machines is the leveling cradle, of which a number of types have been developed to set the flask with reference to the pattern board regardless of irregularities in the bottom board upon which it rests.

but it is not certain that the packing of sand in this way was altogether original with Hainsworth, and there is ample ground to suspect that groceries of all kinds have been packed in paper bags by the same jolting process since time immemorial, and some of these (dried currants, for instance) there is reason to believe have always contained a liberal admixture of sand. The packing of sand by jarring is therefore in all probability as old as the hills, but since the broad claim of Hainsworth no longer troubles us we must look among later improvements within the field that he covered for the development of the art. This patent seems to have attracted very little attention when it appeared and no further inventions along this line are on record until 1878, when Jarvis Adams gave some impetus to the art and later followed it by a number of patents. The Adams machines were, however, rather crude and very little progress in the art was really made until compressed air came into general use as a medium for the transmission of power.

At the present time nearly all jarring machine builders contemplate the use of compressed air, whereas originally and until about the beginning of the present century, they were operated mainly by hand or by cams on a power shaft. The development of the jarring machine is an interesting study, but no attempt will be made to follow it through all its ramifications; a few examples only representing the last ten years will be considered. In the machine first built the jarring table was struck underneath by a heavy plunger actuated by compressed air. The blow raised the table a short distance from its support, upon which it fell back, striking a second blow. Some of these machines are still in use, but it cannot be said that they are very efficient or successful, and they were superseded five or six years ago by the Tabor jarring machine now in common use.

This is a plain machine with the jarring cylinder formed in the table mounted upon an upstanding plunger. By this construction the table is given enormous strength and stiffness and the central blow of impact is distributed equally in all directions. The plunger is part of a heavy piece of cast iron forming the anvil, which in turn rests upon a large mass of concrete. Originally the main valve was operated directly by tappets attached to the table adjustable for any desired length of stroke, and later it was modified to operate through the medium of a pilot valve. To avoid unnecessary intensity in the blow struck by the table upon its anvil a few layers of leather or other non-resilient material are introduced as a cushion. These reduce the wear and tear and noise, without having any material effect upon the action of the machine on sand. The plunger base rests upon concrete to form an anvil.

As to the mass of concrete, it may be said from the operating standpoint the more the better, but this must be limited, of course, with regard to the cost and the natural bed beneath. In a general way, about two cubic feet of concrete for every square inch of area in the jarring cylinder is recommended, but if there is a rock bottom beneath, the use of very little concrete is advisable, or just enough to level up under the cast-iron plunger base. Some builders recommend more concrete than this, some less, and in addition to the concrete a heavy wooden cribwork is frequently put in beneath to prevent the transmission of the shock of impact into the ground. This is in accordance with the usual practice under steamhammer anvils, and it may have some beneficial effect but it does not eliminate the whole trouble and the wooden crib is scarcely worth its additional cost. It is not generally safe to set up finished molds with hanging sand in the neighborhood of a jarring machine of this type and in some foundries the jarring machine has been put out of service for days or weeks pending the completion of large floor work. In fact, the damaging effect of large jarring machines is too well known to need confirmation, and to reduce this to a minimum the drop of the table has been decreased while the foundation has been increased.

But there is a limit to the relief afforded by reducing the drop, because upon this the ramming effect primarily depends. The shorter the stroke the less the ultimate density attained and the less the efficiency of the machine. This can be demonstrated in a practical way by ramming up a deep mold on short strokes until the sand ceases to pack any further. Increasing the length of the stroke very considerably alters the effect of the next blow. The sand will pack further immediately and the conclusion in favor of the long stroke as more efficient in packing sand is inevitable.

With the object of eliminating ground shock and yet retaining the use of any stroke desired the shockless jarring machine, Fig. 9, has been designed. It requires no foundation other than a base to sustain the static load upon it, and it is more efficient in operation than a plain machine mounted on a wooden crib whose anvil weighs twice as much. The principle upon which it operates will be understood from the sectional elevation shown in Fig. 12. The plunger base forming the anvil is mounted for convenience in an anvil cylinder and rests upon a number of long compression springs. When air is admitted to the jarring cylinder the entire weight of the anvil, table, and load is carried upon these springs and they are therefore compressed and in readiness to expand when the air is exhausted and the table falls. At the beginning of this movement the loaded table is impelled downward by the same force that moves the anvil upward, and although some of the force of the springs is exhausted as the anvil rises, the loaded table and the anvil acquire substantially equal momenta which neutralize each other when impact takes place. To compensate in a measure for the loss of spring pressure as the anvil rises, the exhaust from the jarring cylinder may be carried into the anvil cylinder before being discharged. This is accomplished by a combination valve, consisting of a large main valve of the steam-hammer type in connection with a small pop valve such as is used on small power squeezers and split-pattern machines. These valves are attached to the anvil or plunger base and the pop valve is opened and closed by tappets on the jarring table. When the table drops the pop valve opens, admitting pressure beneath the main valve, which rises and puts the jarring cylinder in communication with the air supply, at the same time opening the anvil cylinder to exhaust. When the limit of stroke is reached the pilot valve opens to exhaust and the main valve drops to the position shown. The air from the jarring cylinder rushes into the anvil cylinder, expanding to much lower pressure, which is nevertheless very effective in the large anvil cylinder and causes

the loaded table and anvil to collide with greater force and effect upon the sand. The supply of air to these valves is controlled by an air cock at the operating stand and the table runs automatically as long as the air is turned on. At the same time the stroke of the table is controlled by another lever adjustable, if desired, while the machine is running. The purpose of the pilot valve is to provide a controlling means, easily manipulated, that will give the delayed action required by the main valve. This always presents full openings during the table movement up or down, and the ample lap on the ports gives time for expansion in the jarring cylinder under light or medium loads after the air supply has been cut off. Of course, under full load, or thereabout, there can be no appreciable expansion in the jarring cylinder.

Fig. 9 is taken from a photograph of a 13-inch shockless machine with 4-foot by 6-foot table. A machine of this type will ram any mold, large or small, in a minute or less time, and the saving to be effected by its use on large work is practically the whole of the ramming time by hand. It will not ram small work, such as that on which time study was first given, as quickly as a squeezer or split-pattern machine, and such a jarring machine for half molds weighing less than 1,000 pounds is not often recommended, but for large deep work particularly it is by far the best machine for packing sand. It is not, however, every pattern that can be rammed in this way, and care must always be taken to avoid projections on the pattern which interfere with the flow of sand. This may necessitate the use of a core not required for hand ramming, but the patterns when mounted for jarring require fewer repairs and the cost of adaptation to the jarring process is soon recovered.

In regard to efficiency, nothing, of course, can be better than an anvil bedded on rock and therefore of practically infinite weight, but even a rock bottom does not prevent the transmission of ground waves, and when a wooden crib is used to cushion the blow the anvil yields to the impact and softens the effect. The advantage of the uprising anvil will therefore be demonstrated and its action illustrated by reference to two cars on a horizontal track. Let these cars be of equal mass or weight and let them be separated a given distance. Now block the wheels of one car and draw the other to it by a uniform force. Assuming the impact to be inelastic the two cars will move on together at half the velocity acquired by the moving car at the time of impact. The shock of collision is the same on both cars, one gains what the other loses, one-half of the velocity of impact, and the square of that change in velocity represents the ramming effect. If the stationary car had been of infinite mass the moving car would have lost all of its velocity and suffered four times the ramming effect.

Or, we may say, to invert the comparison, when one car strikes another of the same weight the ramming effect is one quarter of what it would be if the car ran into a stone wall, or encountered a mass so much superior as to have substantially the effect of infinite mass in checking its velocity. Now, if both cars are free to move and are drawn together by the same force as in the first instance, the same amount of kinetic energy will be developed, but it will be divided between the two cars and totally absorbed by inelastic impact, each car sustaining one-half the shock instead of one-quarter. Therefore, when both cars move together the shock of impact is twice as great as when one car waits to receive a blow from the other one. Furthermore, the highest efficiency, or the greatest shock, is realized between any given pair of cars for any amount of work done when both cars are actuated by the same force and acquire equal momenta in equal times. This is true for cars of unequal weight as well as for the cars of equal weight just considered, and it can be shown when one car is made heavier than the other to act as an anvil that when both cars are free to move the shock on the lighter car is greater than it would be against a car of double the weight standing to receive the blow. It is not claimed that the shockless jarring machine is always twice as efficient as a plain machine having the same weight of anvil mounted on a wooden crib, although it is sometimes more than twice as efficient. It is simply maintained that the shockless jarring machine is more efficient than a plain machine having an anvil twice as heavy mounted on a wooden crib. But the efficiency of a jarring machine does not depend altogether upon the weight of its anvil, solidity of construction contributes something and the length of stroke still more.

Instances could be cited where production has been increased five times by the installation of a jarring machine and still greater gains have been made from machines which combine the jarring and pattern drawing features just described.

Fig. 10 shows such a power roll-over machine in combination with a jarring machine.

Fig. 11 shows a grinder frame mold made on the same machine. This half mold was made by two men ing ten minutes and a complete mold, including core setting, could be made in half an hour.

Originally two men made two molds a day by hand. With the aid of a jarring machine they made five a day, and it appears from the time taken on a combination machine that twenty a day might be expected.

Although the foregoing is not a complete summary of the art of machine molding and many types of machines have necessarily been omitted, the point to which particular attention may be called is the harvest awaitint the introduction of scientific management in the foundry and its bearing upon the proper selection and use of molding machines.

The History of the Kimberley Mines*

The Rise and Development of the South African Diamond Fields

By E. M. Weston

THE story of the rise and development of the diamond-mining industry in South Africa as represented to-day in the deep mines and huge treatment plants of Kimberley, and the immense open workings of the Premier mine in the Transvaal, is as full of romance and interest as that of the discovery of gold in California or Australia. The art of diamond mining, including treatment of diamondiferous ground, has followed along parallel lines to that of metallic minerals. The first diamond miner was the brother of the alluvial gold miner and worked with similar appliances.

DISCOVERY OF DIAMONDS.

The discovery of diamonds in South Africa came much later than that of gold in California. It was in 1867 that the children of Daniel Jacobs, a Boer farmer living near Hopetown on the Vaal River in Cape Colony, brought in a bright pebble which they had picked up at play. This was noticed by S. Van Neikerk and J. O'Reiley, who showed it to the civil commission of Colesberg, M. L. Boyes, and Dr. Atherstone, of Capetown. They pronounced it a diamond worth £500. A little interest was excited, but for over a year no other finds were made and it was not until 1869 that a magnificent stone weighing 83.5 carats was found in the possession of a witch doctor. This was named the Star of South Africa and was sold for $125,000 to Earl Dudley. This of course started a rush.

A so-called expert, J. R. Gregory, was sent from England to investigate the country. He declared the prospects hopeless, stating that the formation of the country was such that no large discoveries need be expected and that any diamond found had been brought by ostriches from the desert. Curiously enough, it is related that a few years later one of the general managers of the De Beers, when taken to see the Rand, in its early stages, pronounced the banket outcrops to be detrital deposits of no permanent value.

WORKING THE RIVER GRAVEL.

Systematic search for diamonds by washing the extensive gravels of the Orange River was started by a party of prospectors from Natal in 1870 and at Barkly West rich diamond-bearing wash was found. Then started a rush like that to California, many gold diggers from California and Australia taking part. Thousands of them lined the river banks. Gravel was washed in rockers having two to three sieves in the feed box, arranged to classify the material, and the concentrate examined on tables or flat stones. The diggers who still work these gravel deposits use a trommel or shaking screen; also a sieve as a hand jig, inverting the contents on a table for the easy examination of the bottom layers.

In September, 1870, some children of a farmer named Van Wyk, residing near the present town of Kimberley, found diamonds in the mud with which their house was plastered. Digging was started on Dutoitspan pipe. In 1871 the Bultfontein De Beers pipe was discovered and in the same year the Kimberley mine, by a party headed by F. Rawstone and T. B. Kisch.

The river diggers flocked to these new discoveries and as no one had any idea that the yellow sand and the calcareous tufa that was found underneath it lying on a decomposed yellow rock went to any depth, or was in its origin or nature different from the river diggings, claims were allotted 31x31 feet, and no one was allowed to hold more than two claims. The Kimberley mine was the richest and contained on the surface between four hundred and five hundred such claims.

These claims were often split up so that there were at one time 1,500 proprietors, some holding only five square yards. Roads were left 15 feet wide, 47 feet apart, across the pipes, which were roughly oval or circular, and each digger hauled his ground to the road and carted it away for treatment. There is an enriched zone, corresponding to the gossan of a mineral lode, in most diamond pipes, caused by mechanical concentration. The lighter decomposition products of the pipe-filling rock being washed away, leaves a concentrate. The effect of this can be seen by looking over the yields of such a mine as the Premier, which at first produced about one carat per load and now gives between one-third and one-fifth of a carat.

TREATMENT METHODS AT KIMBERLY.

The first diggers treated the ground by pulverizing it with shovels, screening it on a coarse sieve to eliminate lumps and rocks and screening a second time on a fine sieve about 2 x 3 feet, hung on hide ropes and rocked by hand. In July, 1871, two Americans started the first steam-driven trommel which could treat thirty loads per day.

The subdivision into single claims and the arrangement of roads soon led to an extraordinary state of affairs. In about one year's time the roads became unsafe as the workings went down into the yellow ground of the pipes, which experiment had shown to be rich in diamonds. The mine was strangely picturesque at this period; hundreds of carts and wheelbarrows, bearing ground to be sorted, were seen on the hazardous narrow roads, while down below, at all distances from the surface, a succession of rectangular ledges represented the various working levels of different claims. Between 10,000 and 12,000 white and native laborers were in one mine busy picking and shoveling ground and piling it into original tubs and buckets, some of these being hauled up by ropes and tackle, others carried by hand up inclined planks and ladders or up staircases cut out in the perpendicular walls. Each man worked on his own device without regard for his neighbor, the only rule being that the roadways must be left intact.

As the claims deepened a system of rope haulage was adopted. Two grooved wheels were fixed, one on the surface and the other in the pit, while to the rope passing around them a bucket was fixed, making a sort of aerial main and tail haulage. In 1874 long lines of timber staging, in three decks, were erected around the walls of the pipe. Aerial rope haulage worked by horsewhims was employed, and in 1875 the first steam winding gear arrived, having cost £30 per ton freight alone from Capetown. In 1874 100 claims were allowed under one ownership, and in 1878 large combines took place, as the ground around the rim of the pipe now began to fall in on the claims 300 to 400 feet below.

Reef falls became more serious as the workings got deeper and many workers were ruined. In 1883 about 25 per cent of the claims were covered with reef, as the wall of the pipes was called, and 10 loads of wash were raised for every three of blue ground. A method was devised by E. Jones for sinking through the fallen rubbish by timber coffer dams. Underground mining was started from shafts sunk at the bottom of the open cut. The last working of this kind was in 1889. The De Beers and Kimberley pipes were the richest, Kimberley being richer than De Beers. The late Cecil Rhodes and I. Rudd had obtained control of De Beers pipe and finally with the help of Alfred Beit, Rothschild and others got control of the Kimberley pipe from Barney Barnato. In 1888 the De Beers Consolidated Mines was formed, which acquired control of the four known pipes. Between 1883 and 1888 under-ground mining had been started from shafts sunk in the rim rock away from the pipe and the present caving system was gradually evolved. Wesseleton mine was not discovered until 1890.

CHARACTER OF BLUE GROUND.

At the time new treatment methods were evolved, the yellow or oxidized portion of the pipe changed in about 50 feet to blue ground, which corresponded to the sulphide zone of metalliferous lodes. The blue ground has been variously described as a porphyritic peridotite; or better as a serpentinized breccia having olivine for its main constituent; or as a clastic mass of serpentinized rounded and angular olivine, with ilmenite, augite, bronzite, calcite, chlorite, chromite, cyanite, zircon, garnet, mica and hornblende.

Treatment methods were improved to deal with this new material. In 1874 washing machines worked by horse-power were in evidence and elevators were employed to stack tailings. Rockers were used as water was discovered in wells and finally it was found that a machine almost identical with the puddler of the alluvial gold miner was most efficient, for floating away the lighter material, and producing a rough concentrate.

* *The Engineering and Mining Journal.*

This developed later into the centrifugal pan, up to 18 feet in diameter, driven by steam power. It has a central shaft carrying revolving arms with stirrers and scrapers tending to throw the heavier material toward the circumference while the lighter material and slime flows away at the center. Steam was late in its introduction on the field owing to scarcity of water and fuel.

De Beers Consolidated controls five pipes around Kimberley: Dutoitspan, with an area of 1440 claims; Wesselton, 1162; Bultfontein, 1067; De Beers, 622; Kimberley, 470 claims. (45.3 claims = 1 acre). The Premier mine in the Transvaal consists of one pipe of about 3570 claims. All the mines except Wesselton are worked by underground methods and the equipment is up-to-date. Electric traction, by 5-ton Baldwin-Westinghouse electric locomotives, is employed underground.

IMPROVED TREATMENT METHODS.

The cost of underground mining and depositing in Dutoitspan mine was in 1907 only 2s. 7d. per load. There are 150 miles of endless rope haulage. Caving methods are employed underground. It was early discovered that blue ground crumbled and decomposed if exposed to the air for some time and this method of rendering treatment easy was adopted in Kimberley. The rock is taken to floors of several square miles in extent, spread out, raked over by harrows driven by steam haulage, guarded night and day for several months and then sent to the treatment plants.

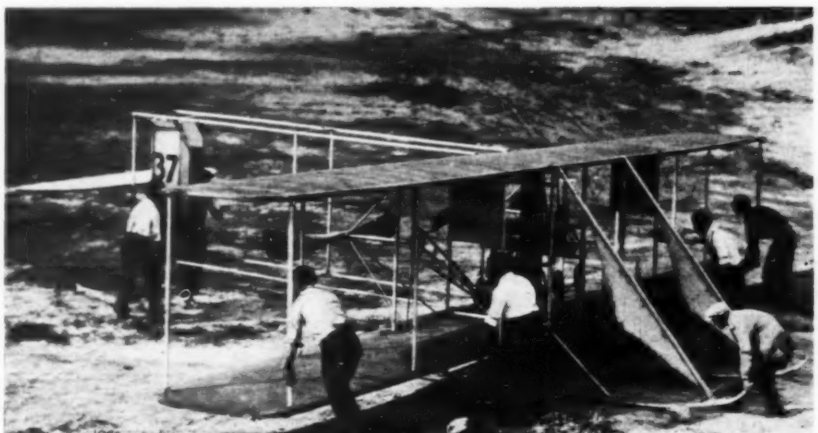
Direct treatment is, however, coming into favor to save the time and expense of working these floors, and at newer mines like the Premier, also at Kimberley, the ore is gradually reduced in size to avoid fracturing diamonds more than is necessary. Crushers and rolls are employed and the method is based on the same principle that is employed to treat a brittle, easily slimed ore such as galena, by a method of gradual reduction to avoid slime losses. Jigs known as pulsators are used to reconcentrate the concentrates from the centrifugal pans which form about one per cent of the bulk of ore treated. The concentrates are finally treated on grease-coated vanners which correspond to the oil separation plants used with lead, zinc and copper ores in metal mining. Diamonds adhere to grease almost as gold does to mercury, while all the other minerals in the concentrate pass off.

The Wright Biplane, Model "B"*

And a Historical Sketch of Its Development

The first thing that strikes an observer on seeing one of the new Model B machines that are being delivered to customers of the Wright Company is the neat appearance of the entire apparatus. This is due not only to the finishing of the parts, but in a great measure to the harmony of the entire design. A cursory glance at the machine does not at once reveal such strength and solidity as a closer examination makes evident. A study of all the various details of construction brings one to realize that every part has been thought over and carefully designed for its particular use and position.

Unlike most of the other machines on the market this one is not intended to be completely taken down for shipment. The front portions of the skids are so hinged that they can be folded back parallel to the main planes, and the foot rest folds up out of the way. The rear outrigger to tail taken off complete, slid between the main planes from one end, and tied to the struts, the machine may be put in an end-opening box car. Of course, the assembling takes a very short while, which is a desideratum for military as well as private use, and there is no danger of the planes being poorly set up.



The Model "B" Wright, with "Blinder" modified at Chicago Meet.

THE WARPING & RUDDER LEVER

The machine is highly finished in every part. Exposed strut-sockets and connections, wires, hinges, straps, planes, etc., are nickel plated. The woodwork is of bright aluminium finish. This is obtained by dusting aluminium powder on a specially prepared wet varnish, giving a harder coat than a covering of varnish alone. This is rubbed down and the final finish is like that of a piano.

OTHER MODELS.

The older machines, as will be remembered, had a biplane elevator out in front and no rear elevator. The machine Wilbur Wright first flew in France, and the first government aeroplane was of this type. Following these two in 1910 a rear elevator was attached and worked in combination with the front elevator. At the Asbury Park exhibition, 1910, the headless machine made its first appearance. This was one of the same machines as then standard, with the front elevator merely removed. With slight increase in the size of the rear elevator, the machines from that time on were headless, and as new machines were built, the outriggers formerly used to support the front elevator were left off. In the Model B, put out in 1911, the front construction was shortened up, and the "blinders" at the front end of the skids were made a little larger. In July the new machines of this model had in addition, a pair of rectangular blinders under the upper surface in the middle section.

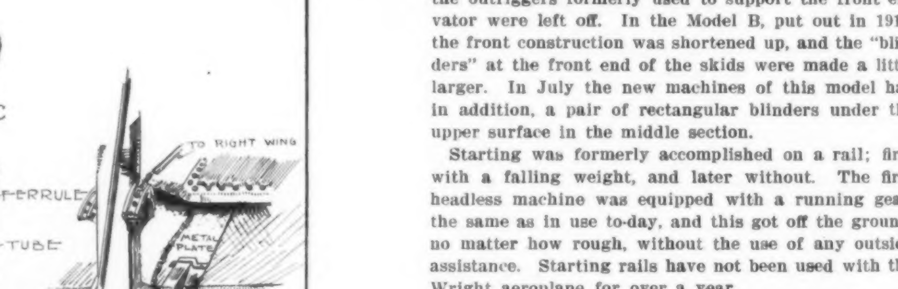
Starting was formerly accomplished on a rail; first with a falling weight, and later without. The first headless machine was equipped with a running gear, the same as in use to-day, and this got off the ground, no matter how rough, without the use of any outside assistance. Starting rails have not been used with the Wright aeroplane for over a year.

Model R, the "roadster," was first shown at a Belmont meet, fall of 1910. The only machine of this type in the hands of sportsmen is that of Alec Ogilvie, in England. This spreads 26½ feet, planes 3 feet 7 inches fore and aft and weighs 585 pounds, equipped with the standard 30 horse-power motor. This type was used by Johnstone when he broke the world altitude record at Belmont, making 9,714 feet. It is without doubt, for the horse-power, the fastest climbing machine in existence, according to times and altitudes measured at Belmont meet. Ogilvie made a speed of 52 miles an hour in the 1910 Gordon-Bennett race with 30 horse-power.

A special racer was built for the Belmont meet, with but 22 feet spread, with a special 8-clinder 60 horse-power motor, but this, unfortunately, was smashed before it crossed the line in the Gordon-Bennett. A 32-foot machine, one passenger, has also been built for exhibition work where the grounds are small.

DETAILS OF MODEL B.

Main Planes.—These have a spread of 39 feet and a chord of 6 feet 2 inches, and are each built up in three sections. The cloth, which is prepared by the Goodyear



DIAGRAMMATIC VIEW WRIGHT CONTROL SYSTEM

* Reproduced from *Aeronautics*.

Tire & Rubber Co., is laid diagonally, being attached to each section separately and the sections laced together. The cloth covers both sides of the planes. The main spars are of spruce, as is the most of the woodwork, 1¾ inches by 1¼ inches, the greatest dimension being vertical in the front spar and horizontal in the rear spar. They are larger in the middle section of the lower plane, being 1¾ inches by 2½ inches for the front and 1¼ inches by 2½ inches for the rear where ash is used. There are 34 ribs to each plane, spaced a foot apart in the center and wider toward the lateral extremities of the planes. The ribs which come near struts are solid between the main spars. The others are built up of an upper and lower strip, with blocks spaced about six inches as distance pieces. The two ribs that support the engine and the two seat ribs are the only ones between the spars of the lower plane for the center six feet.

There are nine pairs of uprights of various sizes, the outer two sets on each end being secured to the planes by the familiar flexible joint, the remainder by a sort of socket joint. A few turnbuckles have made their appearance in the center section. This is doubtless in order to be able to replace the engine or other parts with greater ease. All the steel piano wires not fitted with turnbuckles are cut to length and are interchangeable. When setting up the planes the wires are attached and the struts are then sprung in place. These guy wires are cut and the loop bent by a special tool at the factory. As the wire used has a breaking strength of from 800 to 2,400 pounds, according to size, it can be seen that once the plane is set up there will be no occasion for further adjustment through the stretching of the wires.

The curve of the planes is 1 in 20, the greatest depth being two-fifths back from the front edge. The aspect ratio is 6.25.

Supplementary Fixed Surfaces.—The little semi-circular blinkers in the 1910 machines have given place to two sets on the latest machines. This is due to the fact that greater area is required, now that the skids have been shortened up. The shape and location of these are shown in the drawings.

Vertical Rudder.—This is, in general, of the same construction as in the early models, although somewhat smaller. The rudder is operated by the combination warping and direction lever, as shown in the sketches. As shown, this lever also warps the wings. By "breaking" the top section "B" either to the left or the right alone (without moving the balance of the lever from its normal or other position), the rudder only is moved to steer left or right, respectively. In making flat turns, without banking, the top section only of the lever is used. The movement is entirely a natural or instinctive one.

This separate movement of the rudder is obtained by having the sector *D*, movably mounted, capable of individual action with respect to lever section *A*, through the steel tube actuated by the section *B* of the lever. The wire which goes over the top of sector *D* must go to the left side of the rudder cross-bar.

Elevator. The front third of this surface is held rigid while the rear two-thirds is flexible. This is operated by a forward and back movement of the elevator lever, the wires being crossed so that pushing out on the lever steers down and pulling toward the operator steers the machine up. The cloth is laid on diagonally and only one thickness is used, the ribs and spars running through pockets in the cloth.

There is a second elevator lever, which can be used by a student passenger, who would then work the warping (and rudder) with his right hand. Some of the Wright aviators use the seat next the engine, with the warping lever at the left. Others, taught by these, sit on the outside seat. This second elevator lever has a disk attached, encompassed on its periphery by a flat steel friction band to hold the lever in any set position.

Transverse Control.—While the control of the machine does not appear to be instinctive, it certainly is easy to learn, and after having been once firmly impressed on the mind, seems to be very satisfactory. It would seem that the exertion of moving the warping lever fore and aft is a great deal less than if it were arranged to move sideways as in some other machines.

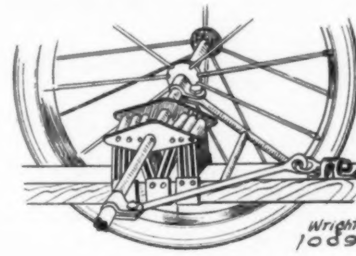
The warping is done by the lever *A*. Pushing forward, raises the left wing and depresses the right. The same movement turns the rudder to the left—the side having the lesser angle of incidence, when the lever as a whole is used, not being broken at the joint *C*.

The wiring for the warping is shown in the diagrammatic sketch. The rear spars of the two end sections of the planes are hinged to those of the center section, so that warping may be accomplished without flexing the spar.

The lever arrangements have varied on many of the machines. Some are flown with the aviator using the left hand for warping. Students taught by these use the right hand for warping, as a rule. This is now the practice in "breaking in" flyers in order that any passenger or other weight they may carry will occupy a central position on the machine and retain the balance. However, one or two machines have been put out with two warping and two elevator levers, for those who desired to fly together and who had both learned the use of the same hand for warping.

THE MAKING OF SPIRALS.

Referring to the sketch of the combination warping and rudder lever, the wooden lever *A* is jointed, or hinged, at the top. The short section *B* turns left or right on the axis *C* for independent rudder action. The lever as a whole moved forward warps the left wing up and the right wing down, at the same time



Wright Running Gear.

turning the rudder towards the left (to offer resistance to the side having the lesser angle of incidence). The elevator is also warped down to enable the aviator to gain speed, and the machine has begun to bank, the right side being the higher.

Next, this combination lever as a whole is gradually brought back to normal position, as the 'plane is now half way to being "on end." At this stage with this lever (as one) normal, and the wings straightened out, the top section of the lever is "broken" over to the left which turns the rudder only to this side. This operation is gone through in making the short circles, or spirals, for which the Wright machine is so famous. The operation for turning to the left has been given. For right spirals the reverse must be done.

Care must be taken to straighten out before the machine has banked at so steep an angle as to make recovery impossible. In the sketch th Section B is broken to the left, turning the rudder only to the left.

Power Plant.—The four-cylinder, vertical motor is rated as 30 to 35, and the brake horse-power runs, on test, in conformity with the rating. Frequently the brake horse-power is more. The engine in Beatty's machine has shown 42 horse-power on the block. The cylinders are 4⅜ inches bore, by 4-inch stroke, rated by the A.L.A.M. at 30.6 horse-power. The gray iron cylinders are cast separate and have aluminium water jackets held in place by steel rings shrunk on. The nickel steel crankshaft is cut from a solid block, as is the camshaft. A camshaft within the crankcase operates overhead valves by means of rocker arms. The connecting rods are of hollow steel with T-shaped ends, on bronze and white bronze bearings. For shutting the motor off the exhaust valves are lifted, when a wire over the head of the operator is pulled. A cut-out is used when desired, to short-circuit the Mea magneto which is driven off the camshaft through the steel gears on the outside of the crank case. Gasoline is fed directly into the cylinders by a gear pump placed on the right side of the engine, the gasoline entering a vertical tube through a jet orifice. This pump controls the amount of gasoline fed the engine in direct ratio with the engine speed. The vertical tube leads to the center of a simple horizontal equalizing manifold which opens direct to the inlet valves. The only method of controlling the engine speed is by advancing or retarding the spark. In the Mea high tension magneto the spark is of the same fatness at any advance, through its manner of construction. A foot lever pushed out against a spring retards the spark for starting the propellers. There is a catch on the magneto to hold it in retarded position so that the operator may start his own machine, without danger of its running off before he gets in the seat. Oiling is effected by a gear pump inside the base, with a glass sight which shows the level of oil in the reservoir from which the oil is pumped to the trough under each cylinder.

The cylinder head and valve cases are not water jacketed, but are made very heavy. The inlet valves are automatic, with light springs. The weight of the bare engine is 180 pounds.

Cooling is through a vertical tube radiator which has a capacity of three gallons, sufficient for 6 hours' running. The tubes of this radiator are now made fish-shape, instead of rectangular as before. Circulation is by centrifugal pump.

The gasoline consumption is about four gallons per hour, the 12-gallon tank carrying sufficient for three hours' flying. A gage on the gasoline tank shows at all times the relative amount of gas remaining in the tank.

The engine is mounted at either end of the base on cross-members which in turn rest on the engine foundation ribs, which are solid. Duplicate sprockets screwed and locked to the crank shaft back of the flywheel, drive through specially made Diamond nickel steel roller chains the two propellers, the gearing being in the ratio of 11 to 34. At an engine speed of 1,325 revolutions, which the engine turns up during flight, the propeller speed is 428 revolutions, with a flying thrust of about 250 pounds. Hess-Bright ball bearings are used. The chain can be tightened by means of the adjustable stay.

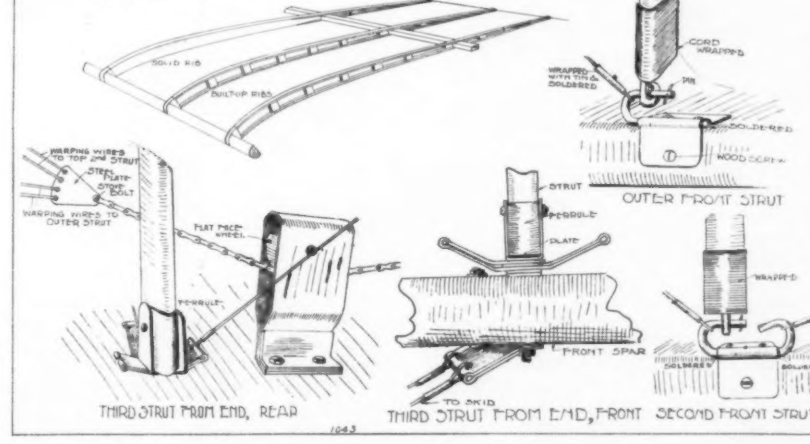
The early engines were 4 by 4 inches, then 4¼ by 4 inches and now 4⅜ by 4 inches.

In starting, the propellers are turned (with the compression "off") to fill the cylinders with gas. Then the compression rod is pushed in, the magneto retarded and the propellers given a quick pull.

In gliding down, or preparing to land, the compression is released and the propellers rotate solely by their impetus or by reason of the air currents, without any braking effect of the pistons. Compression may be obtained again during flight by pushing back the rod mentioned above.

Landing Gear.—Wheels are used in combination with the usual skid arrangement. There being no need for the skids extending so far forward, after having done away with the front elevator, the skids have been shortened until they are only long enough to make the likelihood of tripping the machine rather remote. The exact mounting of these wheels is illustrated herewith.

Weight.—The machine weighs, with operator and passenger, ready to fly, in the neighborhood of 1,250 pounds. The weight thus carried per horse-power is about 40 pounds. The weight carried per square foot of supporting surface, on the above basis, figures out at 2½ pounds. Lancaster gives the Wright machine an efficiency of 63 per cent, after deducting 5 per cent for loss in the chains. The new book by Eiffel, just published, makes the remarkable statement, in view of the known facts, that it takes 30 horse-power to fly the Wright machine, which is obviously an erroneous conclusion.



THE WRIGHT MACHINE BY YEARS.

In the early power machines of 1903 to 1905, the aviator was flat on his stomach and the engine, even,

was laid on its side. In 1905 the rudders and elevator were placed farther from the main planes.

In the spring of 1908, after a period of three years devoted to business negotiations and experiment, flights were renewed at Kitty Hawk, N. C., the scene of the early glides and power flights, and the world "sat up and took notice" for the first time. Later in the year, Wilbur Wright went to France with one machine, while Orville demonstrated another at Washington. After creating untold interest in Europe, Wilbur returned to this country. In the meantime the unfortunate accident occurred at Washington and a year later a new machine was demonstrated to the army officials and accepted. Then the experiment was made by Wilbur Wright at College Park of taking off the upper surface of the front biplane elevator and attaching it rigidly to the tail, at the rear of the rudder. Next, this rear stabilizer was made movable and connected with the elevator lever, working in conjunction with the front elevator, which was generally used as a biplane.

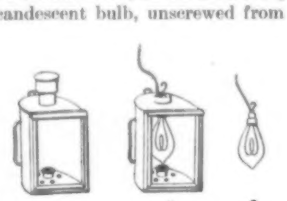
In the summer of 1910, after a number of exhibitions had been given throughout various cities of the United States by a corps of aviators who were taught to fly at Dayton, a machine made its appearance at Asbury Park's exhibition, minus the front elevator altogether. It was just merely left off, the usual supporting struts remaining. From that time on, all machines were made headless and the two diagonal struts which stuck out were sawn off and small "blinders" were put on. Next, the front outriggers were shortened up, bringing the machine to its present state.

Interesting New French Inventions

Ingenious Devices for Common Use

ELECTRIC LIGHT FOR PHOTOGRAPHIC DARK ROOM.

THE electric light is extremely convenient for photographers' use, in consequence of the ease and quickness with which it can be lighted and extinguished. Several specially constructed electric lamps are sold, but the following inexpensive and home made arrangement is as good as any: Take a dark-room lantern of the simplest and cheapest candle type, and remove the chimney. Open the front and insert, in an inverted position, an ordinary incandescent bulb, unscrewed from its socket,



1 2 3

so that the top of the bulb rests on the candle support at the bottom of the lantern. Then insert the socket of the bulb, with its attached flexible cord, through the chimney hole, and screw the bulb and socket together. If the lantern and the bulb are of suitable size, the latter will be firmly held. It is now only necessary to stop the upper orifice of the lantern around the lamp socket with a piece of cloth to prevent leakage of light.

SUPPORT FOR SMOOTHING IRONS.

It is frequently desirable to support a smoothing iron in an inverted position, for the treatment of velvets, laces, silk ribbons, and other delicate fabrics which would be crushed by the weight of the iron. It is not always very easy to support a hot iron. This difficulty is overcome by the simple support here shown. It is made of

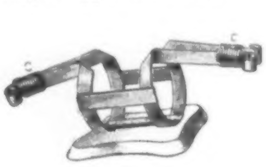


Fig. 1.

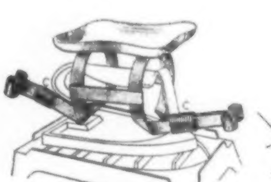


Fig. 2.

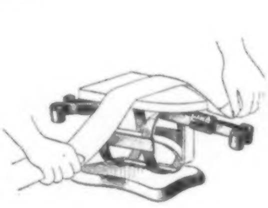
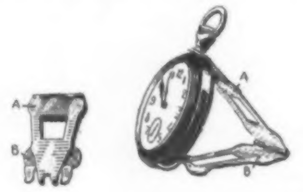


Fig. 3.

barrel hoops, and the ends form pincers which are clamped by two rings, *CC*, (Fig. 1). The handle of the iron as it rests on the stove is seized by the two pincers, which are tightened by means of the two rings (Fig. 2). In this position the iron is erect and the support is inverted. All that is now necessary is to take hold of the support by its base and invert it with the iron (Fig. 3).

POCKET WATCH SUPPORT.

A watch should not be laid flat on a table at night, because this position produces unequal wear of the ends of the arbors. For this reason, and also in order to be

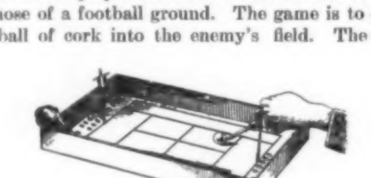


able to see the hour without difficulty, various supports have been contrived to hold a watch in a vertical or nearly vertical position.

The very simple support here shown is so small that it can be carried in the pocket, and will be found very useful in traveling. It is little more than a hinge, one leaf of which *B* rests on the table, while the other *A* supports the stem of the watch. When removed from the watch, the hinge automatically closes by the operation of a spring.

WIND BALL.

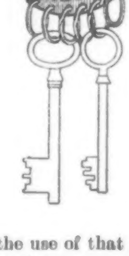
Wind ball is played on a board divided into two fields like those of a football ground. The game is to drive a little ball of cork into the enemy's field. The ball is



driven by puffs of air directed upon it by rubber bulbs with suitable mouthpieces. The ends of the cloth-covered table are slightly inclined, and contain a number of holes into which the ball can be driven.

KEY RING.

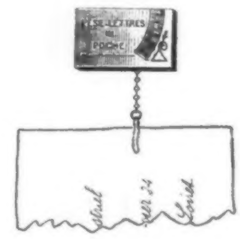
In the key ring or frame here pictured each key is attached to a compartment of a metal frame which bears



a mark indicating the use of that particular key. All of the indications are written on a piece of paper which is held tightly between the two plates which compose the frame. The paper can easily be changed.

POCKET LETTER SCALE.

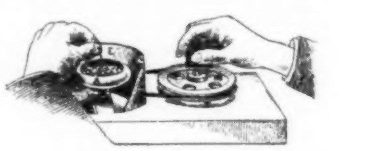
A smaller and lighter letter scale than the one shown in the illustration could scarcely be imagined. It is about two inches long, one inch wide, and one-fifth inch thick, and its weight is less than one-half ounce, yet it is capable of weighing, with considerable accuracy,



letters as heavy as two ounces (60 grammes). The device consists of an elastic strip of metal, of which one end is fixed. Near the other end is attached a short chain, from which the letter is suspended. The strip of metal is inclosed in a flat metal box, the front of which has a slit in the form of an arc of a circle, which is graduated from zero to 60 grammes. The free end of the elastic strip of metal moves over this graduation.

A BEAD-STRINGING MACHINE.

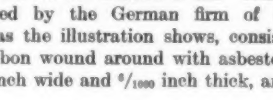
The first operation in the manufacture of ornaments composed of beads consists in stringing the beads on wires or cotton or silk threads. This work is usually done by hand, by girls, and it cannot be performed rapidly even by the expert operators. A very complicated machine would be required to perform the entire operation, as the beads may vary greatly in size and form, and it is difficult to bring each bead into the correct position for stringing. A French inventor, Mathieu, has devised a simple apparatus which is not a complete bead-stringing machine, but rather a tool which facilitates the work of stringing beads by hand. The beads are placed promiscuously in a bowl having a strongly incurved rim (*A* in the illustration), which is rotated



rapidly by means of a belt passing around a wheel (*M*). The operator turns this wheel with her right hand, while with her left hand she plunges a long curved needle into the bowl of beads, near its rim, holding the needle so that its point is directed opposite to the direction of rotation. In these conditions the swiftly revolving beads automatically string themselves on the needle, which is soon entirely covered with them. The operator then sweeps the needleful of beads on to the thread or wire which is attached to the needle and the operation begins anew. The action of this simple device is based less on mechanical principles than upon the theory of probability and of averages. Of the large number of beads in the bowl some are certain to present their holes to the point of the needle. The beads that are thrown out of the bowl by their impact upon the needle are caught by the screen *E* and roll into a drawer, which when full, is emptied into the bowl.

RESISTANCE ROPE.

A very cheap material for the construction of electric resistance and electric heaters is the "resistance rope" manufactured by the German firm of Schmewindt. The rope, as the illustration shows, consists of a thin metallic ribbon wound around with asbestos. The ribbon is $^1/_{12}$ inch wide and $^6/_{1000}$ inch thick, and is capable



of carrying a maximum current of 10 amperes. A rope 40 inches long has a resistance of 4 ohms. For use with very strong currents a number of ropes are connected in parallel. For example, three ropes, each 15 feet long, connected in parallel, will carry a total current of 30 amperes. The resistance of the combination will be 6 ohms, and it will convert about 5½ kilowatts of electric energy into heat, as 1 watt is consumed in each 10 inches, of rope.

A KEY STOPPER.

Keys with tubular shafts often become partly or entirely filled with dust and lint, so that they cannot be inserted in the lock to the proper depth, until they have been laboriously cleaned with a long pin. This inconvenience is obviated by a new French device, consisting of a cover a little larger than the key barrel, pro-

vided with two springs which hold it tightly against the end of the barrel by their pressure upon the interior surface of the barrel. At the moment of using the key the stopper is removed and either held in the hand or placed in a tubular holder attached to the key-ring, shown in the middle illustration.—*La Nature.*

Methods of Controlling Steam Engines*

Governors and Regulators

By John Davidson

GOVERNORS CONTROLLED THROUGH RELAY MOTORS.

WHERE the governor of a steam engine is required to actuate a heavy valve gear, it is difficult to obtain sufficient power, combined with sensitiveness in the governor itself, unless it be made of massive proportions; even then the friction and wear of the governor renders it an unsatisfactory piece of mechanism. Such valve gears as the Meyer and Ryder are included in this class. The gears themselves are positive, and are suitable for engines running at all speeds, but considerable force is required to move the gear to suit the variation in load.

Among the many appliances used in connection with

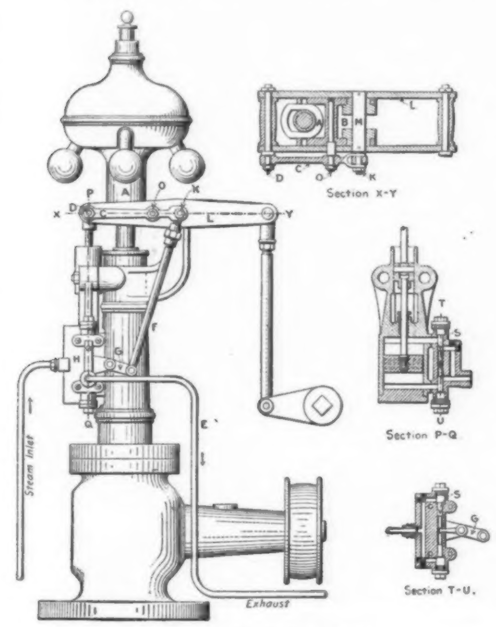


Fig. 1—Lude Relay Gear.

governors as a relay gear, that invented by Lude many years ago and illustrated in Fig. 1, is perhaps the simplest in general use. With this arrangement, the only work done by the governor proper consists in controlling the piston valve of a miniature steam engine, the piston rod of which is connected to the expansion gear to be actuated. By the use of an ingenious combination of levers the motion of the piston and its connections is made to correspond with that of the governor, and, even with a very slight variation in load, the piston moves over a corresponding distance under the full steam pressure.

Referring to Fig. 1. the motion of the governor sleeve A is transmitted by means of the double lever B, to the lever C which is pivoted at D to the main lever L. The short arm of the lever C is connected by means of the rod F to a small lever G which actuates a small piston valve arranged in the casing H at one side of the steam cylinder. This valve controls the steam admission and exhaust ports of both ends of the cylinder. The arrangement is such that both sides of the piston are connected with the exhaust pipe when the valve occupies its central position, while a small movement of the valve in either direction will admit steam at one end of the cylinder. The resulting motion of the main piston rod and lever L, with its connections, causes the piston valve to return to its central position so as to again open both

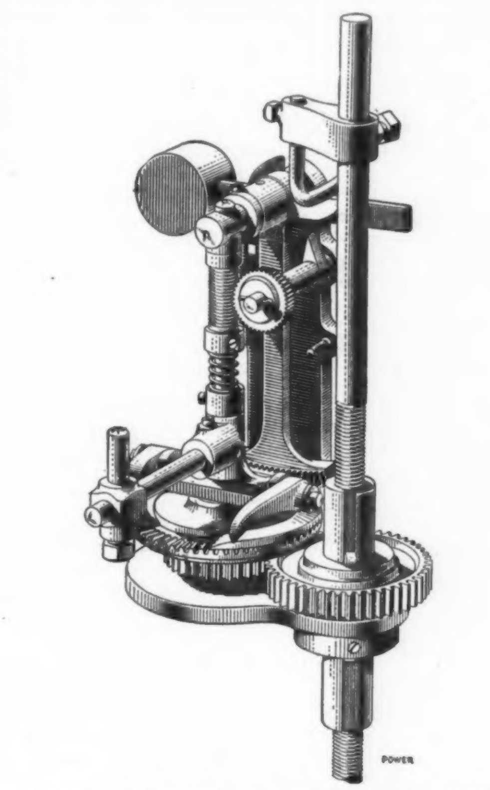


Fig. 3—Regulator Made by British Metallic Packing Company.

sides of the piston to the exhaust pipe, when the lever L has been turned through an angle corresponding to the movement of the governor sleeve. Normally, the center of the joint K corresponds with the turning axis M of the lever L. When the governor sleeve is moved the lever C is caused to turn about the center D, thereby raising or lowering the center K. The resulting movement of the lever L causes the lever C to turn about the center O and the center K is consequently returned into line with the axis M of the main lever L. As the steam flows at a high velocity the movement of the lever L is practically simultaneous with the movement of the governor sleeve.

REGULATORS OR SUPPLEMENTARY GOVERNORS.

With the ordinary type of governor it is impossible to keep the speed of the engine constant if the load or the steam pressure varies, because the governor cannot effect any change in the valve gear or pressure of the steam admitted to the engine until a change in speed has actually taken place. To obviate this defect, supplementary governors or regulators are used.

There are many designs of regulators in general use, more particularly in connection with engines driving cotton mills, etc., where it is necessary to maintain a constant speed. One of the oldest and perhaps most largely used of these is the Higginson regulator, illustrated in Fig. 2, which automatically balances the governor, in whatever position it assumes, to correspond to a variation in the load or steam pressure. This is effected by altering the level of mercury contained in the two cylinders at the ends of the arms which form the regulator, these being originally attached to the governor rocking ring. The mercury cups are connected by a pipe, and the weight of mercury at each end of the regulator depends upon its angular position, the cylinders being accurately proportioned to the governor. This regulator answers exceedingly well for mills where the variation in load or steam pressure does not take place rapidly.

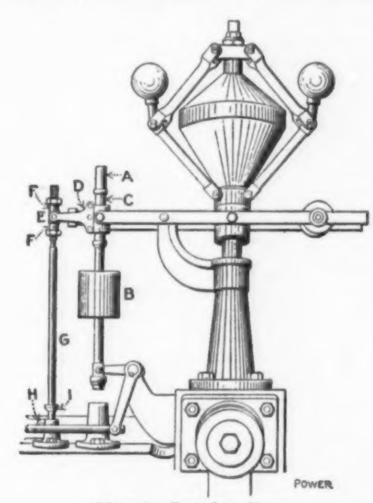


Fig. 4—Speeder Gear.

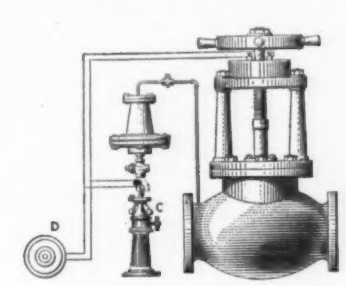


Fig. 5—Tates Electric Stop.

Another regulator, made by the British Metallic Packing Company, is shown in Fig. 3. The two parts of the governor rod, one with a right-hand thread and the other with a left-hand thread, are joined together by a sleeve. If this sleeve is revolved, the governor rod is lengthened or shortened according to the direction in which it is turned, and alters the valve motion, to give more or less steam to the engine as required. The governor-rod sleeve is rotated by means of a gear wheel, the sleeve sliding through the wheel and rising or falling in the usual manner, quite independent of the wheel. The sleeve wheel meshes with another wheel which is mounted on an upright spindle, and on the top of the latter wheel is a plate which has teeth on its upper face. Over this tooth-faced wheel is a movable shield plate which has a portion cut away so as to uncover a number of teeth on the face wheel, and over the shield plate is placed a pawl carrier actuated from some suitable mov-

* Reprinted from *Power*.

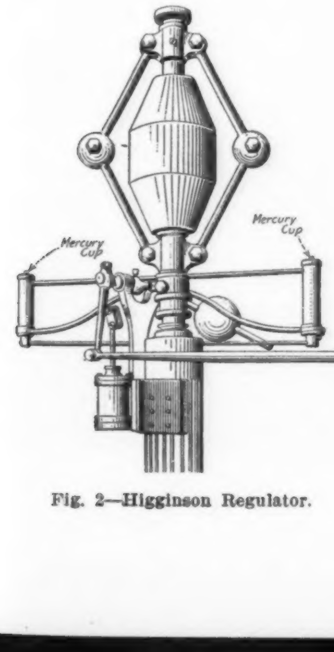


Fig. 2—Higginson Regulator.

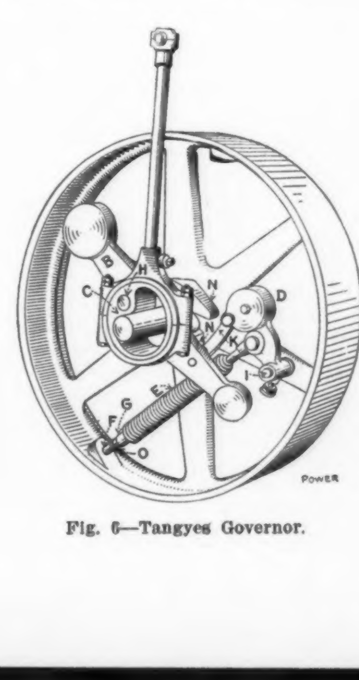


Fig. 6—Tangyes Governor.

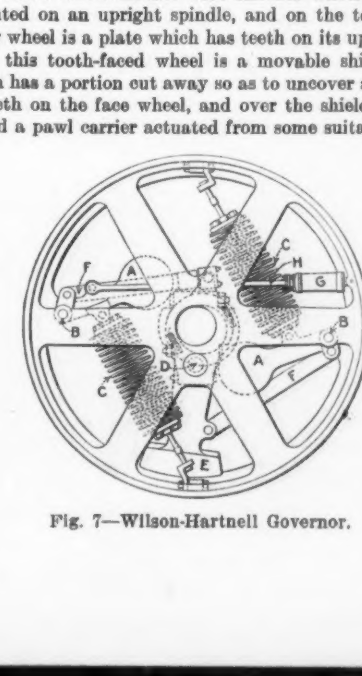


Fig. 7—Wilson-Hartnell Governor.

ing part of the engine, the pawls riding on the shield plate. At the top of the bracket is pivoted a three-armed lever, two of the arms being horizontal and the other vertical; the bottom end of the latter is provided with teeth which mesh into teeth formed on the shield plate. The illustration shows the pawls in the center of their travel, which ends when the pawls drop into the teeth of the face wheel.

The governor rod is shown at its normal height, and one horizontal arm of the lever is held in firm contact with it by means of a weight on the other horizontal arm. It is evident that if the governor rises or falls the T-lever follows it and at the same time moves the shield plate and uncovers one or more teeth to be moved by the pawls. The action of the T-lever is very sensitive, about 1/16 inch rise or fall of the governor uncovering one tooth on the face wheel. The spindle revolves with the face wheel and carries a worm which meshes with a gear, automatically throwing the regulator out of action at any predetermined position.

A special feature of the regulator is that the two spur wheels can be changed, or any other wheels put on so as to obtain the exact speed of regulation suitable for the engine to which it is fixed.

SAFETY TRIP GEARS.

Safety trip gears are generally fitted to all engines where the governor is driven through intermediate gearing, such as a belt or ropes. By this means, should the belt or ropes break, or should they be carried away on account of some portion of the engine itself breaking, the steam is immediately cut off. In addition to this, the engine is immediately shut down should the speed exceed any predetermined amount.

A type of speeder gear used in connection with Porter, Proell and similar types of governors controlling trip gears of Corliss and drop-valve engines is illustrated in Fig. 4. Rod *A*, forming the connection between the governor and the valve gear, is weighted by the pot *B* so as to slide in the bush *C* should the catch *D* be released. This takes place whenever the block between the ends of the pair of tee-shaped levers *E* come into contact with the nuts *F F* on the trip rod *G*. These nuts are adjusted so as to come into action during about the last ½ inch of movement of the governor at both top and bottom. The tripping rod *G* rests on the top of the engine frame, and is prevented from lifting by the hinged quadrant *H*-engaging with a collar on the end of the rod. To prevent the safety trip acting every time the engine stops, it is only necessary, just before shutting off steam, to turn the quadrant *H* until it catches under the collar *I* on the trip rod, the weight of the latter preventing the quadrant from falling. This allows the trip rod to lift when the engine stops and the governor falls, instead of releasing *D*; but in doing this it allows the quadrant *H* to drop. As soon as the engine starts again and the governor lifts, the trip rod *G* is lowered, and its bottom collar will again engage with the quadrant, thus automatically resetting the gear in its safe position. It will be seen that the gear, if properly adjusted, will act if the governor reaches its top position through overspeeding, also, if the governor falls to the bottom through the failure of its driving gear, unless intentionally prevented from doing so by the attendant propping the trip rod by means of the quadrant as described.

Another well known safety trip gear is the "Tates Electric Stop Motion," shown in Fig. 5. In this trip gear the main stop valve of the engine is closed by a powerful spring should the speed of the engine exceed any predetermined amount. In addition to this, if the engine is condensing, the vacuum is broken. Also, by means of suitable electrical connections the engine stop valve can be instantly closed from any part of the building by simply pressing a push button.

A small governor shown at *C* is driven by means of a belt from the engine shaft. If the engine runs at an excessive speed the tumbler at the top of the governor makes contact and the stop valve of the engine is immediately closed. If, however, the small belt driving this governor should break while the engine is running, the engine is instantly shut down.

CRANK-SHAFT GOVERNORS.

Governors of the crank-shaft or drum type which control the speed of the engine by altering the travel and angle of the eccentric driving the valve, are not largely used in England. In the early days of high speed engines, they were largely used and are still used by a few firms, but most makers of this class of engine have abandoned this type of governor and use the throttle type universally. For small engines, crank-shaft governors are very suitable, and a design of governor used by Messrs. Tangyes of Birmingham, England, is illustrated in Fig. 6.

This governor consists of an inertia arm *B*, with which is cast the eccentric *C*, pivoted on the steel pin *H*, and free to swing within the limits provided by the stops *N N*. The weight box *D*, carried upon the pivot *I*, is connected to the governor arm by link *K*, and the spring *E* tends to pull the arm *B* against the stop *N*. When the direction of rotation is in a clockwise direction, the action of the governor is as follows: The weight *D* flies out radially when the wheel is rotated, and moves the governor arm by means of the link *K*. The inertia arm *B* lags behind, and assists the weight *D* either at an increase or a decrease of speed. This has the effect of either increasing or decreasing the travel of the eccentric and the cutoff of the equilibrium piston valve is adjusted to the required work. The eccentric in the position shown is at the maximum travel, such as when the engine is starting up. Upon the required speed being attained, the center of the eccentric moves toward the center of the shaft, and the travel of the valve is reduced. The weight box *D* contains loose weights secured by a cover plate and bolt; by removing one of the weights the speed of the engine is increased about five revolutions, and the entire number of weights gives a variation of about fifty revolutions. The required spring strength for best working is obtained by a plug in the spring *E*, which can be moved by the box spanners *G*. The position of this plug is secured by locknuts *O*.

A very powerful and at the same time sensitive type of crank-shaft governor is shown in Fig. 7, which is made by Messrs. Wilson, Hartnell & Co.

The two centrifugal weights *A A* pivoted at *B B* are restrained by the springs *C C*. The eccentric is pivoted at *D* and has a counterbalance weight fitted at *E*. The movement of the centrifugal weights is transmitted to the eccentric by the links *F* and the counterbalance for the eccentric at *E* makes the governor act partly as an inertia governor. A dashpot is fitted at *G* and is coupled to the centrifugal weight by the rod *H*. This is found necessary in order to resist the thrust of the eccentric.

Science Notes

Keeping the Pedigree of Milch Cows.—At a meeting of the French Agricultural Society, M. Vacher spoke of the good results obtained in Normandy by a milk-controlling society. Following the example of similar bodies in Denmark and Sweden, a herd book is used to keep track of the cows and their descendants so that only the best animals for milk producing are selected. This applies also to the males, whose qualities are transmitted. Such animals are much preferred by buyers and bring a higher price.

Tomato Oil.—The production of tomato oil is an industry of a recent date. The oil is obtained from the seeds, a waste product from the process of preserving tomatoes. In the province of Parma, Italy, 84,000 tons of tomatoes have been consumed during the past year. The total production in Italy, representing eight million dollars, of which two and one-half represented exports. The 84,000 tons mentioned yield waste material amounting to 13,000 tons, four-fifths of this being water. Pressing reduces it further to 4,000 tons, consisting chiefly of the seeds. By a process of cold compression, eighteen per cent of tomato oil is obtained. The 84,000 tons of tomatoes therefore yield 600 tons of oil. This oil is very dry and of a golden yellow color. It is used for the manufacture of varnish and as a fuel.—*Seifenfabrikant.*

The Influence of Gas and Electric Light on the Purity of the Air.—Tests on the influence of light sources on the air of a dwelling room were made in a room 14 feet long, 12 feet wide and 12 feet high, provided with one door and two windows, also a latticed ventilator 8 inches from the floor and one on the opposite side 8 inches from the ceiling. For the first experiment a tantalum electric lamp was burned; for the second experiment a Welsbach gas light of like candle-power was used. Tests made after a three hours' burning showed that the electric light increased the amount of carbon dioxide by 0.154 per cent, the gas light by only 0.131 per cent. The fact that a larger amount of carbon dioxide may be found when electric lights are used has been attributed to the hotter gas flame, which causes a more effective circulation of the air and therefore removes the carbonic acid gas more speedily.—*Chemiker Zeitung.*

The Influence of Gas and Electric Light on the Quality of Beverages.—If cocoa is made of soft water, a pleasant and rich drink is obtained which after short boiling deposits the cocoa powder. Even if the cocoa is made into a paste with a litle water and the cup then filled up with hot water, the largest part of the powder will precipitate and the beverage will still be rich and pleasant. If, however, hard water is used, flakes will at once appear, and the oil in the cocoa will be seen floating on the surface of the drink. The flakes will soon settle and the beverage is far less tasty than the one obtained with soft water. Similar observations may be noticed in the preparation of soups, epecially oatmeal, etc., which remain flaky even after long boiling. In the preparation of tea the hard water causes the formation of a thin film, which does not appear when soft water is used. These phenomena are all due to the presence of calcium and magnesium compounds in hard water.—*Zeitschr. Chem. Ind. Kollside.*

Trade Notes and Formulæ.

Flexible Mirror.—Apply to a sheet of paper or of fabric coated with egg white one or two coatings of transparent varnish and before it is quite dry apply a sheet of tinfoil to it. When this adheres properly, pour quicksilver on it, as is customary in coating, moisten the paper and strip it off.

Soldering Powder for Steel.—The following recipe is given by Micrzinski; 300 parts of borax, 200 parts of ferrocyannide of potassium and 1 part of Prussian blue are boiled down in water and dried out under application of heat. The cooled mass is pulverized and mixed with 100 parts of wrought iron filings. This soldering powder is used on the white-hot steel.

To Clean Tarnished Silver.—*a*. Keep for half an hour in hyposulphate of soda 4 parts, salammoniac 2 parts, ammonia 1 part, cyanide of potassium 1 part, dissolved in 40 parts of water. *b*. Boil in saturated solution of borx. *c*. Boil in potash lye, in contact with zinc. *d*. Polish with precipitated chalk, mixed with 1 part of curd soap.

Varnish for Alcohol Casks (of pine and larch wood). Thirty-three parts of good joiners' glue, softened in sweet milk and boiled down fairly thick, 3 parts fine gall-nut powder added, 6 parts pulverized glass, 5 parts cement lime and 3 parts linseed oil varnish. Subsequent addition of a few parts of flowers of sulphur may be made if desired. To be applied luke warm (by opening the bung stave). Water must not be put in these casks.

Luminous Powder.—One hundred parts of calcined mussel shells, chiefly giant clam and sepia, 100 parts burnt lime, 25 parts calcined sea salt, and 60 to 100 parts of sulphur are mixed, and the mass is very carefully heated to redness in a crucible. By the admixture of 6 to 7 per cent of barium sulphide, freshly heated to redness, we obtain a greenish phosphorescent light, with sulphide of strontium a reddish light. Must be kept in a glass vessel and protected from the light.

Casting Compound for Toys.—Fifty parts of finely crushed and washed clay slate is stirred with 20 parts of rag paper pulp and 30 parts of calcined plaster and a sufficiency of water into a paste, which is poured into locked wooden molds, previously brushed with finely pulverized slate, powdered gypsum or some fatty substance. After some time the superfluous, still fluid compound can be poured out and the articles removed from the molds. Free from moisture by drying; further treat in the familiar manner and finally color as desired.

Varnish for Toys.—*a*. Melt in an iron kettle, stirring the while, 32.5 parts of yellow transparent American rosin, previously crushed into small pieces. After melting remove from the fire and add in the kettle 48.75 parts of turpentine, stirring vigorously. Strain through a woolen cloth and preserve in large glass bottles. *b*. In a roomy tub, dissolve, without heat, 12.5 parts of crushed pale transparent American rosin and 0.625 part of Venice turpentine, in 18.75 parts of 85 or 90 per cent alcohol, stirring all the time, and filter. The varnish should be preserved in carefully closed bottles.

Rubber-like Mass for Toys.—Starch flour is mixed with oxide of zinc and tartar or pulverized alum, in varying proportions, according to the character of the object to be produced. A good recipe is 20 to 100 parts of oxide of zinc, 5 to 10 parts of tartar or burnt alum, to 1 part of starch flour. If we dissolve chloride of zinc in water, so that the solution is about 42 deg. Be., not over 50 deg. Be., nor below 40 deg. Be. strong, and stir this and the mixture together. A dough like mass will result, which can be rolled flat with the rolling cylinder and used for the production of hollow objects, by pressing in molds. They can then be stuck together by means of an adhesive substance.

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